Issued June 1968

SOIL SURVEY

Wright County, Minnesota

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
MINNESOTA AGRICULTURAL EXPERIMENT STATION

Major fieldwork for this survey was completed in the period 1955–1961. Soil names and descriptions were approved in 1965. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1960–1965. This survey was made cooperatively by the Soil Conservation Service and the Minnesota Agricultural Experiment Station; it is part of the technical assistance furnished to the Wright County Soil and Water Conservation District.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY of Wright County contains information that can be applied in managing farms and woodlands; in selecting sites for roads, ponds, buildings, or other structures; and in appraising the value of tracts of land for agriculture, industry, or recreation.

Locating Soils

All the soils of Wright County are shown on the detailed map at the back of this survey. This map consists of many sheets that are made from aerial photographs. Each sheet is numbered to correspond with numbers shown on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbol. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information in this survey. This guide lists all of the soils of the county in alphabetic order by map symbol. It shows the page where each kind of soil is described, and also the page for the capability unit, woodland group, or any other group in which the soil has been placed.

Individual colored maps showing the relative suitability or limitations of soils for many specific purposes can be developed by using the soil map and information in the text. Interpretations not included in the text can be developed by grouping the soils according to their suitability or limitations for a particular use. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils in the section that describes the soils and in the section that discusses management of the soils for various kinds of crops.

Foresters and others can refer to the section "Woodland," where the soils of the county are grouped according to their suitability for trees.

Engineers and builders will find under "Engineering Uses of the Soils" tables that give engineering descriptions of the soils in the county and that name soil features that affect engineering practices and structures.

Community planners and others concerned with suburban development can read about the soil properties that affect the choice of homesites, industrial sites, schools, and parks in the section "Soils and Community Developments."

Scientists and others can read about how the soils were formed and how they are classified in the section "Formation, Classification, and Morphology of Soils."

Students, teachers, and others will find information about soils and their management in various parts of the text.

Newcomers in Wright County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the County," which gives additional information about the county.

Cover picture.—Contour stripcropping for control of erosion on sloping soils.

U.S. GOVERNMENT PRINTING OFFICE: 1968

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Washington, D.C. 20402

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NOTICE TO LIBRARIANS

Series year and series number are no longer shown on soil surveys. See explanation on the next page.

Issued June 1968

EXPLANATION

Series Year and Series Number

Series year and number were dropped from all soil surveys sent to the printer after December 31, 1965. Many surveys, however, were then at such advanced stage of printing that it was not feasible to remove series year and number. Consequently, the last issues bearing series year and number will be as follows:

Series 1957, No. 23, Las Vegas and Eldorado Valleys Area, Nev.
Series 1958, No. 34, Grand Traverse County, Mich.
Series 1959, No. 42, Judith Basin Area, Mont.
Series 1960, No. 31, Elbert County, Colo. (Eastern Part)
Series 1961, No. 42, Camden County, N.J.
Series 1962, No. 13, Chicot County, Ark.
Series 1963, No. 1, Tippah County, Miss.

Series numbers will be consecutive in each series year, up to and including the numbers shown in the foregoing list. The soil survey for Tippah County, Miss., will be the last to have a series year and series number.

SOIL SURVEY OF WRIGHT COUNTY, MINNESOTA

BY RUSSELL J. EDWARDS, SOIL CONSERVATION SERVICE

FIELD SURVEY BY ROBERT A. LUETH, EDMUND R. MEIR, WOODROW W. ANDERSON, PAUL R. NYBERG, ROBERT C. MUNTER, ALEX S. ROBERTSON, GRENFALL F. HARMS, H. R. CLINE, AND RUSSELL J. EDWARDS, SOIL CONSERVATION SERVICE, AND ROUSE S. FARNHAM, MILO HARPSTEAD, RICHARD O. WIRTH, ROLAND R. LARTER, LARRY ADAMS, AND JOHN E. FOSS, MINNESOTA AGRICULTURAL EXPERIMENT STATION

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE UNIVERSITY OF MINNESOTA AGRICULTURAL EXPERIMENT STATION [1]

WRIGHT COUNTY is in the east-central part of Minnesota (fig. 1). It has a land area of 671 square miles, or 429,440 acres. An additional 45 square miles, or 28,800 acres, is in water. The county is on the southwestern bank of the Mississippi River and is also partly bordered by the Clearwater and Crow Rivers, which makes the shape of the county irregular. Buffalo, the county seat, is 35 miles from Minneapolis and 40 miles from St. Paul, the State Capital.

All of Wright County has been glaciated, and as a result, the topography consists of outwash plains, gently rolling to steep hills, and many marshes and lakes. Agriculture is the leading occupation, and in 1964, nearly 91 percent of the land was in farms. Most of the farm income comes from dairy products and from grain grown for cash. The main crops are corn, alfalfa, hay, oats, and soybeans. Woodland occupies nearly 15 percent of the acreage and provides wood products for use on the farm and also some cash income. Some income also comes from vacationers, for the county is a popular resort area.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Wright County, where they are located, and how they can be used. They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many other facts about the soils. They dug or bored many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by roots of plants.

[1] Other organizations that assisted in preparing this survey are the Lake States Forest Experiment Station, the Minnesota Department of Conservation, the Minnesota Highway Department, the Wright County Agricultural Extension Service, and the U.S. Bureau of Public Roads.

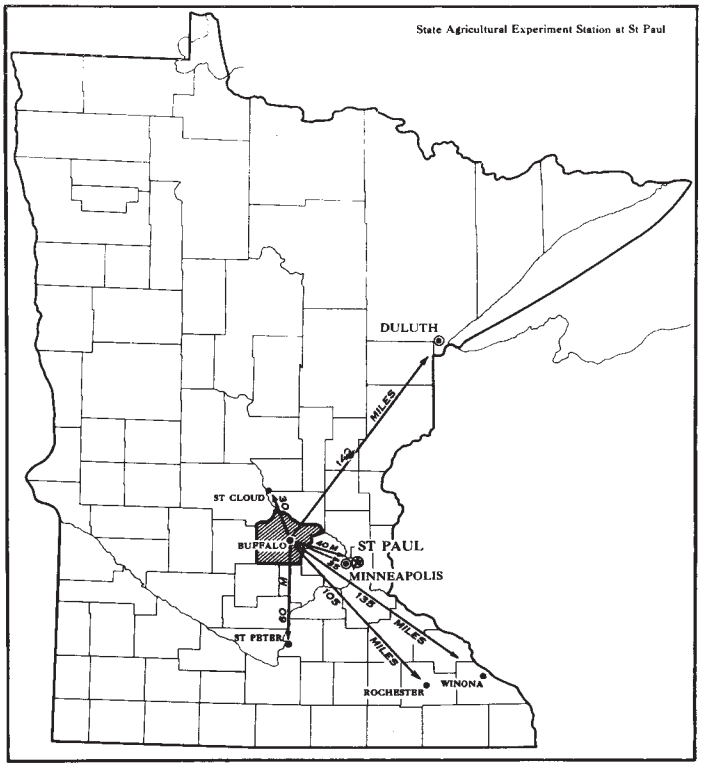

Figure 1.—**Location of Wright County in Minnesota.**

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to uniform procedures. For successful use of this report, it is necessary to know the kinds of groupings most used in local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or

other geographic feature near the place where a soil of that series was first observed and mapped. Glencoe and Blue Earth, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that go with their behavior in the natural landscape.

Many soil series contain soils that differ in texture of their surface layer. According to such differences in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Hayden fine sandy loam and Hayden loam are two soil types in the Hayden series. The difference in texture of their surface layers is apparent from their names.

Some soil types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects management. For example, Lester loam, 2 to 6 percent slopes, is one of several phases of Lester loam, a soil type that ranges from nearly level to very steep.

After a detailed guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that greatly help in drawing boundaries accurately. The soil map in the back of this report was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed, and so small in size, that it is not practical to show them separately on the map. Therefore, they show this mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major kinds of soil in it, for example, Emmert-Milaca complex, 2 to 6 percent slopes. Also two or more soils may be mapped as an undifferentiated unit if the differences between them are too slight to justify separation. An example is Cordova and Webster silty clay loams. The major difference between the Cordova and Webster soils is the content of clay in the subsoil.

On most soil maps some areas are shown that are so rocky and shallow or so frequently worked by wind and water that they cannot be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Beach materials, sandy, or Lake borders, and are called land types rather than soils.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soils in other places are assembled. Data or yields of crops under defined practices are assembled from farm records and from field or plot experiments in the same kinds of soils. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in a way that it is readily useful to different groups of readers, among them farmers, managers of woodland, engineers, and homeowners. Grouping soils that are similar in siutability for each specified use is the method of organization commonly used in the soil survey reports. On the basis of yield and practice tables and other data, the soil scientists set up trial groups, and test them by further study and by consultation with farmers, agronomists, engineers, and others. Then the scientists adjust the groups according to the results of their studies and consultation. Thus the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map in the back of this survey shows, in color, the soil associations in Wright County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of farming or other land use. Such a map is not suitable for planning the management of a farm or field, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect management.

There are seven soil associations in Wright County. Associations 1 through 6 are in the uplands, and association 7 is on outwash plains and terraces.

1. Lester-Le Sueur-Cordova Association

Deep, medium textured and moderately fine textured soils on nearly level and gently sloping uplands

This soil association is mostly in the southern part of the county, but small areas are in the central part. It is nearly level and gently sloping and contains many potholes and marshes. It occupies about 14 percent of the county.

The soils in this association formed in material derived from loamy glacial till having a high content of lime carbonate. They have high fertility and high capacity to supply moisture. Tall grasses made up the original vegetation, but deciduous hardwood forest gradually encroached on the prairie.

This association consists mainly of the Lester, Le Sueur, and Cordova soils, but it also includes minor areas of Glencoe soils and of peaty soils. The Lester soils are sloping and well drained. Their surface layer is loam, and their subsoil is clay loam. The Le Sueur soils are nearly level to gently sloping and not quite so well drained as the Lester, but are somewhat finer textured. The Cordova soils are on broad flats. They are poorly drained and range from clay loam to silty clay loam in texture. In the depressions and drainageways are the Glencoe soils and the peaty soils, all of them very poorly drained. The Glencoe soils are deep and silty, and the peaty soils are underlain by silty material at variable depths.

If the soils in this association are well managed, they are excellent for crops. Grain grown to be sold for cash is the principal crop, and corn and soybeans are grown intensively. Large areas of sweet corn for canning are grown in the southwestern part of this association. Dairying is important on about a third of the farms and is a large operation on a few farms. Most of the pastures are wet and partly wooded. Several large tracts of mixed prairie and woodland are in the area, and most farms have small woodlots. The average farm is between 150 and 160 acres in size.

Drainage is the main problem of management, mainly because suitable outlets are lacking. About 35 percent of the acreage needs drainage. Also needed in this association is management that maintains tilth and productivity. Most areas of the Glencoe soils and of the peaty soils are too wet for crops, but tile has been installed to provide drainage in large areas of the Cordova soils. Erosion is a hazard on the gently sloping soils.

2. Lester-Hayden-Peat Association

Deep, medium textured and moderately fine textured soils on rolling uplands

This soil association, the largest in the county, consists of rolling areas. Slopes are generally short and irregular. Peat bogs and marshes occur. The association includes many large and small lakes. It makes up about 40 percent of the county.

The mineral soils in this association formed in material from glacial till that is similar to the till of the soils in association 1. The native vegetation was deciduous hardwood forest or prairie grass on which forest was encroaching.

The Lester soils are sloping and occupy the largest acreage in this association. The Hayden soils are generally in steeper areas and near lakes and streams. Both are well drained and have a loam surface layer and clay loam subsoil. They generally are leached free of lime to a depth between 30 and 40 inches. The Lester soils have a fairly thick, dark-colored surface soil. The Hayden soils have a dark-gray surface soil and a subsurface layer that is lighter gray. Peaty soils are in most of the depressions. These peaty soils vary in depth and generally are underlain by silty material.

Less extensive soils in this association are the poorly drained Cordova on flats, the very poorly drained Glencoe in some depressions, and the moderately well drained Le Sueur on nearly level and gentle slopes.

The soils in this association generally are good for crops. Dairy farming predominates, and corn, oats, and alfalfa are the principal crops. On about one-fourth of the area in crops, the chief crops are grains grown for cash. The low, wet meadows and bogs are used for pasture and wild hay. Most of the acreage is cleared, but wooded pastures and small woodlots are common. The average farm is between 130 and 140 acres in size.

On soils of this association, the hazard of erosion, lack of drainage, and difficulty of maintaining soil tilth and productivity are the chief management problems.

3. Hayden-Dundas-Peat Association

Deep, medium textured and moderately fine textured soils on gently rolling upands

This soil association is in the northeastern part of the county. It is gently rolling and has many flats and depressions. About 7 percent of the county is in this association.

The mineral soils in this association formed under a hardwood forest in loamy glacial till having a high content of lime. The soils are mostly deep loams and silt loams that have a subsoil of clay loam to silty clay. They contain only a small amount of organic matter.

Predominant in this association are the Hayden soils, which are sloping and are well drained. On the flats are large areas of the poorly drained Dundas soils. The surface layer of the Dundas soils is dark-gray silt loam, and this is underlain by a lighter gray subsurface layer. The finer textured, plastic subsoil restricts movement of water. In most of the depressions are peaty soils underlain by silty material.

Dairy farming predominates in this soil association. Less corn is grown than in the southern part of the county, and the number of farms on which swine are raised for market is increasing. Most farms are 140 to 160 acres in size.

The soils in this association are productive if the fertility and content of organic matter are maintained and other good management is used. Tile drainage is needed on about one-third of the acreage before it can be used for crops, but the Dundas soils are slowly permeable and lack suitable outlets. Pastures on the Dundas soils generally are wet and partly wooded (fig. 2). The sloping areas in this association generally are moderately eroded and the steeper areas are severely eroded.

4. Hayden-Lester-Peat Association

Deep, medium textured and moderately fine textured soils on strongly rolling and hilly uplands

This soil association, which includes some of the roughest land in the county, consists of strongly sloping, hilly areas. Slopes are very irregular. Many lakes, marshes, and bogs are in the area. About 18 percent of the county is in this association.

The mineral soils in this association formed in material derived from loamy glacial till having a high content of lime. The Hayden soils occupy the largest acreage, and in places they are intermingled with Lester soils Both are well drained, deep, and sloping. They

Figure 2.—**Typical view of heavily grazed, wooded pasture on Dundas soils in the Hayden-Dundas-peat association.**

have a loam surface soil and a clay loam subsoil, but the Lester soils have a somewhat darker colored and thicker surface layer than the Hayden. Peaty soils are in most of the depressions.

Less extensive soils in this association are the poorly drained Cordova and Webster, in some depressions, and the very poorly drained Glencoe soils in the upper part of drainageways.

The less sloping soils in this association generally are good for crops if properly farmed. Dairy farming predominates in this association, and about equal acreages are used for corn, small grains, and pasture. Most of the acreage is cleared, but deciduous hardwoods occupy small areas in the association, and the pastures generally are partly wooded or are wet and peaty. The average farm is between 80 and 100 acres in size. About 25 percent of the farmers also work off the farm.

The chief management problems on soils of this association are the hazard of moderate to severe water erosion on the Lester and Hayden soils, the lack of drainage on the wet soils, and the low content of organic matter in the Hayden soils.

5. Emmert-Milaca-Peat Association

Shallow and deep, moderately coarse textured and medium textured soils on steep uplands

This association, the smallest in the county, occupies rugged hills, steep slopes, and marshy depressions. It is in the northern part of the county, slightly west of Ida Lake. Less than 1 percent of the county is in this association.

The mineral soils in this association formed in material derived from acid, reddish glacial till of different origin than the glacial till in other parts of the uplands. They have a surface layer that ranges from gravelly loam to silty loam in texture. Their content of organic matter is low. In many places stones and boulders are on the surface and throughout the soils.

Predominant in this association are the Emmert soils, which are sloping and are moderately coarse textured. These soils are shallow over reddish, gravelly material. Their fertility and capacity to supply moisture are low. Intermingled with the Emmert soils are the less sloping Milaca soils, which are deep and well drained. Milaca soils have a medium-textured surface soil and are underlain by reddish, moderately fine textured material. Peaty soils are in most potholes and sloughs in this association.

About 35 percent of the acreage in this association is in crops. The rest is heavily wooded or is in pasture. Erosion is severe in most areas that have been cropped. The Milaca soils are less sloping than the Emmert and generally are good for crops, but they generally occur in the same fields as the Emmert, which are droughty.

Dairy farming predominates in this association. Economic returns are marginal, and many of the farmers also work at other jobs off the farm. The farms average about 80 acres in size and are the smallest in the county.

6. Burnsville-Hayden-Peat Association

Shallow and deep, moderately coarse textured and medium textured soils on very steep uplands

This soil association is in the northwestern part of the county. It is very steep and hilly and contains many marshy depressions (fig. 3). The topography is generally very steep, rough, and irregular, but it is somewhat less steep and mostly rolling to hilly in a small area near Sugar Lake. This association makes up about 3 percent of the county.

The mineral soils in this association are mostly sandy loams and gravelly sandy loams. They are shallow to calcareous sand and gravel and have a low content of organic matter. Also they are very droughty, and if cultivated, they are subject to erosion.

The excessively drained Burnsville soils, on strong slopes, occupy the largest acreage in this association, but the well-drained Hayden soils are intermingled with them in small areas. The surface layer of the Burnsville soils ranges from sandy loam to loam in texture. The subsoil is moderately coarse textured to medium textured. Depth to gravel and sand is less than 24 inches. The sandy loams are in the steeper areas, and in some places the soils are very cobbly and stony. Fertility is moderately low to low, and the capacity to supply moisture is low. Hayden soils are deep and have a surface layer of sandy loam or loam. Peaty soils are in most depressions.

More than 60 percent of the acreage of this soil association is in wooded pasture. Stands of aspen, red oak, and basswood are in several areas. The soils are a good source of sand and gravel, and several commercial pits are in this association. Also within this association are resorts at several lakes, which provide recreation for many.

Dairy farming predominates in this soil association. Economic returns are marginal, and many of the farmers also work at other jobs off the farm. Most farms are 80 to 100 acres in size.

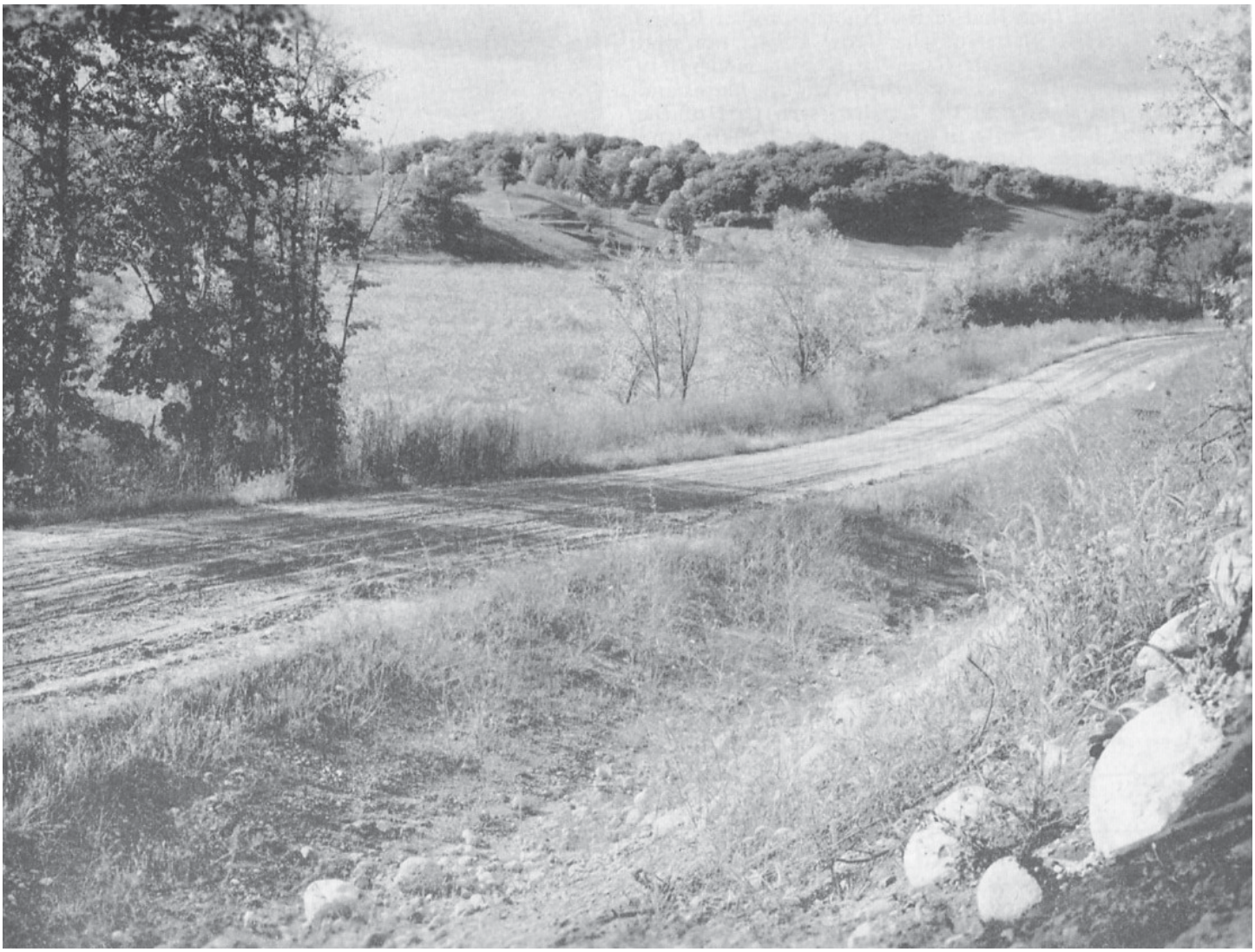

Figure 3.—**Typical view of Burnsville-Hayden-peat association. Burnsville soils are on very steep, irregular slopes of the hills and peaty soils are in low areas in marshy bogs.**

7. Estherville-Hubbard-Wadena Association

Shallow and moderately deep, moderately coarse textured and medium textured soils on nearly level and undulating outwash plains and terraces

This association consists mostly of nearly level and undulating soils on plains and terraces that border the Mississippi and Clearwater Rivers. A fairly large, more rolling area is along the North Fork of the Crow River. Between terraces in this association, and between the terraces and the bottom lands, are narrow areas that have strong slopes. The bottom lands generally are wet, dissected by old channels, and subject to flooding. This association makes up about 17 percent of the county.

The soils in this association generally are sandy and are underlain by sand and gravel deposited by glacial melt water. They are variable in depth and texture and in their capacity to supply moisture. Most of the soils are shallow or moderately deep, but some moderately deep and deep, silty soils are in the northwestern part of the county, where there are many lakes. Drought and wind erosion are serious problems throughout this association.

Estherville and Hubbard soils are predominant in this soil association. Both are somewhat excessively drained to excessively drained and have low to very low capacity to supply moisture. They are underlain by sand and gravel at a depth of less than 24 inches. Hubbard soils consist of loamy sand or sandy loam and are underlain by deep deposits of noncalcareous sand. Estherville soils are sandy loam or loam throughout and are underlain by calcareous gravel and sand. The well-drained Wadena soils, also major soils in this association, have a surface soil and subsoil of loam and are underlain by calcareous sand and gravel at a depth between 24 and 36 inches.

Less extensive in this association are soils of the Chelsea, Rasset, Fairhaven, and Biscay series. Chelsea soils are excessively drained and have a thin surface soil that

is lighter colored than that of the Hubbard soils. Rasset soils, on outwash plains of the Crow River, are well drained and sandy. Fairhaven soils are silty, moderately deep, and well drained. They occupy outwash plains and stream terraces mostly in the northwestern part of the county. The Biscay soils, in flats on outwash plains, and stream terraces, are poorly drained.

Most of the acreage in this association is cleared, but oak and aspen occupy many small areas in the northwestern part of the county. Also fairly dense stands of hardwoods are in areas near Clearwater Lake. On most farms the chief crops are grains grown for cash, but dairying is important on a few farms. Corn and soybeans are the principal crops, and winter wheat and rye are grown on a small acreage. The farms in this association average 200 acres in size and are the largest in the county.

The soils in this association are a good source of sand and gravel, and many commercial pits (fig. 4) are within the association. Also within this association are resorts at lakes near Annandale, in the northwestern part of the county, which provide fishing and opportunities for other recreation for many.

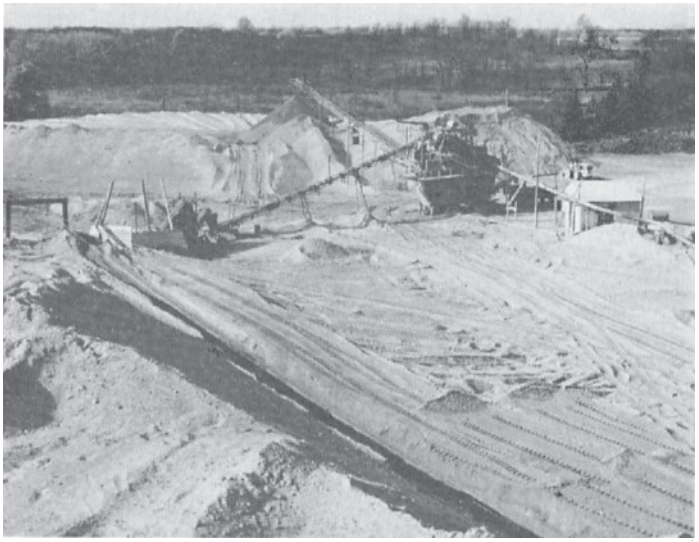

Figure 4.—**A large sand and gravel pit in Estherville soils in the Estherville-Hubbard-Wadena association.**

Descriptions of the Soils

This section is provided for those who want fairly detailed descriptions of the soil series and mapping units in Wright County. For more general information about the soils of the county, the reader can refer to the section "General Soil Map," in which broad patterns of soils are described. More detailed descriptions of the soil series are given in the section "Formation, Classification, and Morphology of Soils." The acreage and proportionate extent of the soils are given in table 1, and their location is shown on the soil map at the back of the report.

TABLE 1.—*Approximate acreage and proportionate extent of the soils mapped*

Soil	Acres	Percent	Soil	Acres	Percent
Alluvial land	3,786	0.9	Burnsville-Hayden complex, 6 to 12 percent slopes	375	.1
Beach materials, sandy	2,727	.6	Burnsville-Hayden complex, 6 to 12 percent slopes, moderately eroded	717	.2
Becker loam	1,226	.3	Burnsville-Hayden complex, 12 to 18 percent slopes	738	.2
Biscay loam	928	.2	Burnsville-Hayden complex, 18 to 35 percent slopes	462	.1
Biscay loam, sandy subsoil variant	173	(1)	Canisteo silty clay loam	2,827	.6
Blue Earth silt loam	1,045	.2	Chelsea fine sand, 2 to 6 percent slopes	231	.1
Braham and Anoka fine sands, 2 to 6 percent slopes, moderately eroded	732	.2	Chelsea fine sand, 6 to 12 percent slopes	92	(1)
Braham and Anoka fine sands, 6 to 12 percent slopes, moderately eroded	402	.1	Chelsea fine sand, 12 to 18 percent slopes	95	(1)
Braham and Anoka fine sands, 12 to 25 percent slopes	184	(1)	Clayey basin land	418	.1
Braham and Anoka loamy fine sands, 0 to 2 percent slopes	360	.1	Comfrey silty clay loam	2,613	.6
Braham and Anoka loamy fine sands, 2 to 6 percent slopes	735	.2	Comfrey silty clay loam, depressional	1,744	.4
Braham and Anoka loamy fine sands, 6 to 12 percent slopes	199	(1)	Cordova and Le Sueur silty clay loams	187	(1)
Burnsville soils, 0 to 6 percent slopes	2,563	.6	Cordova and Webster silty clay loams	26,503	6.2
Burnsville soils, 2 to 6 percent slopes, moderately eroded	2,763	.6	Duelm and Watseka soils	464	.1
Burnsville soils, 6 to 12 percent slopes	1,312	.3	Dundas silt loam	3,608	.8
Burnsville soils, 6 to 12 percent slopes, moderately eroded	2,423	.6	Dundas and Ames silt loams	4,777	1.1
Burnsville soils, 6 to 12 percent slopes, severely eroded	405	.1	Emmert-Milaca complex, 2 to 6 percent slopes	190	(1)
Burnsville soils, 12 to 18 percent slopes	2,130	.5	Emmert-Milaca complex, 6 to 12 percent slopes	343	.1
Burnsville soils, 12 to 25 percent slopes, severely eroded	718	.2	Emmert-Milaca complex, 12 to 18 percent slopes	343	.1
Burnsville soils, 18 to 35 percent slopes	2,417	.6	Emmert-Milaca complex, 18 to 35 percent slopes	558	.1
Burnsville-Hayden complex, 2 to 6 percent slopes	202	(1)	Estherville loam, 0 to 2 percent slopes	2,348	.5
Burnsville-Hayden complex, 2 to 6 percent slopes, moderately eroded	314	.1	Estherville loam, 2 to 6 percent slopes	2,057	.5
			Estherville loam, 2 to 6 percent slopes, moderately eroded	1,689	.4
			Estherville loam, 6 to 12 percent slopes	82	(1)
			Estherville loam, 6 to 12 percent slopes, moderately eroded	232	.1
			Estherville sandy loam, 0 to 2 percent slopes	3,733	.9

See footnote at end of table.

TABLE 1.—*Approximate acreage and proportionate extent of the soils mapped*—Continued

Soil	Acres	Percent
Estherville sandy loam, 2 to 6 percent slopes	3,980	0.9
Estherville sandy loam, 2 to 6 percent slopes, moderately eroded	4,038	.9
Estherville sandy loam, 6 to 12 percent slopes	738	.2
Estherville sandy loam, 6 to 12 percent slopes, moderately eroded	2,383	.5
Estherville sandy loam, 12 to 18 percent slopes	603	.2
Estherville sandy loam, 18 to 25 percent slopes	388	.1
Estherville soils, 6 to 12 percent slopes, severely eroded	700	.2
Estherville soils, 12 to 25 percent slopes, severely eroded	377	.1
Fairhaven silt loam, 0 to 2 percent slopes	418	.1
Fairhaven silt loam, 2 to 6 percent slopes	368	.1
Fairhaven silt loam, 2 to 6 percent slopes, moderately eroded	180	(1)
Fairhaven silt loam, 6 to 12 percent slopes, moderately eroded	49	(1)
Glencoe silty clay loam	31,108	7.2
Guckeen silty clay loam, 0 to 2 percent slopes	233	.1
Guckeen silty clay loam, 2 to 6 percent slopes	331	.1
Guckeen silty clay loam, 6 to 12 percent slopes	51	(1)
Hayden clay loam, 6 to 12 percent slopes, severely eroded	979	.2
Hayden clay loam, 12 to 18 percent slopes, severely eroded	2,560	.6
Hayden fine sandy loam, 0 to 2 percent slopes	106	(1)
Hayden fine sandy loam, 2 to 6 percent slopes	3,105	.7
Hayden fine sandy loam, 2 to 6 percent slopes, moderately eroded	3,638	.8
Hayden fine sandy loam, 6 to 12 percent slopes	1,718	.4
Hayden fine sandy loam, 6 to 12 percent slopes, moderately eroded	4,278	1.0
Hayden fine sandy loam, 12 to 18 percent slopes	2,038	.5
Hayden fine sandy loam, 12 to 18 percent slopes, moderately eroded	1,137	.3
Hayden loam, 2 to 6 percent slopes	13,670	3.2
Hayden loam, 2 to 6 percent slopes, moderately eroded	22,520	5.2
Hayden loam, 6 to 12 percent slopes	5,795	1.3
Hayden loam, 6 to 12 percent slopes, moderately eroded	17,297	4.0
Hayden loam, 12 to 18 percent slopes	3,081	.7
Hayden loam, 12 to 18 percent slopes, moderately eroded	5,030	1.2
Hayden loam, 18 to 25 percent slopes	4,096	.9
Hayden loam, 25 to 35 percent slopes	4,410	1.0
Hayden soils, 18 to 25 percent slopes, severely eroded	898	.2
Hubbard loamy sand, 0 to 2 percent slopes	2,637	.6
Hubbard loamy sand, 2 to 6 percent slopes	2,239	.5
Hubbard loamy sand, 2 to 6 percent slopes, moderately eroded	944	.2
Hubbard loamy sand, 6 to 12 percent slopes	609	.1
Hubbard loamy sand, 6 to 12 percent slopes, moderately eroded	651	.2
Hubbard loamy sand, 12 to 35 percent slopes, moderately eroded	1,029	.2
Hubbard loamy sand, gravelly subsoil variant, 0 to 2 percent slopes	620	.1
Hubbard loamy sand, gravelly subsoil variant, 2 to 6 percent slopes	518	.1
Hubbard loamy sand, gravelly subsoil variant, 2 to 6 percent slopes, moderately eroded	247	.1
Hubbard loamy sand, gravelly subsoil variant, 6 to 12 percent slopes	340	.1
Hubbard sandy loam, 0 to 2 percent slopes	2,121	.5
Hubbard sandy loam, 0 to 2 percent slopes, moderately eroded	558	.1
Hubbard sandy loam, 2 to 6 percent slopes	1,525	.3
Hubbard sandy loam, 2 to 6 percent slopes, moderately eroded	1,095	.2
Hubbard sandy loam, 6 to 12 percent slopes	109	(1)
Hubbard sandy loam, 6 to 12 percent slopes, moderately eroded	222	0.1
Lake borders	2,303	.5
Lester clay loam, 6 to 12 percent slopes, severely eroded	910	.2
Lester clay loam, 12 to 18 percent slopes, severely eroded	1,129	.3
Lester clay loam, 18 to 25 percent slopes, severely eroded	169	(1)
Lester loam, 2 to 6 percent slopes	25,519	6.0
Lester loam, 2 to 6 percent slopes, moderately eroded	25,412	6.0
Lester loam, 6 to 12 percent slopes	3,081	.7
Lester loam, 6 to 12 percent slopes, moderately eroded	18,668	4.3
Lester loam, 12 to 18 percent slopes	2,777	.6
Lester loam, 18 to 25 percent slopes	706	.2
Lester loam, 25 to 35 percent slopes	304	.1
Lester silt loam, silty variant, 0 to 2 percent slopes	99	(1)
Lester silt loam, silty variant, 2 to 6 percent slopes	127	(1)
Lester silt loam, silty variant, 2 to 6 percent slopes, moderately eroded	78	(1)
Lester silt loam, silty variant, 6 to 12 percent slopes, moderately eroded	49	(1)
Lester-Estherville complex, 2 to 6 percent slopes	166	(1)
Lester-Estherville complex, 2 to 6 percent slopes, moderately eroded	350	.1
Lester-Estherville complex, 6 to 12 percent slopes	449	.1
Lester-Estherville complex, 12 to 18 percent slopes	104	(1)
Le Sueur clay loam, 0 to 2 percent slopes	10,507	2.4
Le Sueur clay loam, 2 to 6 percent slopes	10,909	2.5
Marna silty clay loam	907	.2
Marsh	17,565	4.1
Milaca loam, 2 to 6 percent slopes, moderately eroded	62	(1)
Muck, deep	815	.2
Nessel silt loam, 0 to 2 percent slopes	652	.2
Nessel silt loam, 2 to 6 percent slopes	2,407	.6
Peat and muck, deep	24,669	5.7
Peat and muck, shallow over loam	11,150	2.6
Peat and muck, shallow over sand	982	.2
Rasset and Hubbard soils, 0 to 2 percent slopes	556	.1
Rasset and Hubbard soils, 2 to 6 percent slopes	2,460	.6
Rasset and Hubbard soils, 2 to 6 percent slopes, moderately eroded	598	.1
Rasset and Hubbard soils, 6 to 12 percent slopes	402	.1
Rasset and Hubbard soils, 6 to 12 percent slopes, moderately eroded	741	.2
Salida gravelly sandy loam, 2 to 6 percent slopes	422	.1
Salida gravelly sandy loam, 6 to 12 percent slopes	496	.1
Salida gravelly sandy loam, 12 to 35 percent slopes	1,892	.4
Salida complex, 2 to 6 percent slopes	306	.1
Salida complex, 6 to 12 percent slopes	684	.2
Salida complex, 12 to 35 percent slopes	1,940	.5
Sattre silt loam, silty variant, 0 to 2 percent slopes	325	.1
Sattre silt loam, silty variant, 2 to 6 percent slopes	571	.1
Storden-Lester loams, 6 to 12 percent slopes, moderately eroded	725	.2
Storden-Lester loams, 12 to 18 percent slopes, moderately eroded	514	.1
Storden-Lester loams, 18 to 25 percent slopes, moderately eroded	246	.1
Storden-Lester soils, 6 to 12 percent slopes, severely eroded	292	.1

See footnote at end of table.

TABLE 1.—*Approximate acreage and proportionate extent of the soils mapped*—Continued

Soil	Acres	Percent	Soil	Acres	Percent
Storden-Lester soils, 12 to 18 percent slopes, severely eroded	380	0.1	Wadena loam, 2 to 6 percent slopes	1,012	0.2
Talcot clay loam	162	(1)	Wadena loam, 2 to 6 percent slopes, moderately eroded	135	(1)
Terril loam, occasionally flooded, 0 to 2 percent slopes	1,637	.4	Wadena loam, 6 to 12 percent slopes, moderately eroded	56	(1)
Terril loam, sandy substratum, 0 to 2 percent slopes	1,781	.4	Webster silty clay loam, silty variant	274	.1
Terril soils, 2 to 6 percent slopes	1,775	.4	Gravel Pits	415	.1
Wadena loam, 0 to 2 percent slopes	2,683	.6	Total land area	429,440	100.0

[1] Less than 0.05 percent.

All of the soils mapped in the county are listed in the "Guide to Mapping Units," along with the map symbols and the management groupings for each. The major soil series in the county, their parent material, and their position on the landscape are shown in figures 5 and 6.

In the pages that follow, the soil series and mapping units are described in alphabetic order, by the name of the series. Each series is described, and then the individual mapping units in that series. As a general rule, only one soil profile is described for each series, and that profile is considered representative for all the mapping units in the series. Some mapping units have a profile that differs somewhat from the representative profile described for the series, but these differences are evident in the name of the mapping unit or are pointed out in the description. Unless otherwise stated, the profile is that of a moist soil.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map in the back of the report. The description of each mapping unit ends with a reference to the capability unit, the woodland suitability group, and the building site group in which the mapping unit has been placed. The capability units, the woodland suitability groups, and the building site groups are all described in the section "Use and Management of the Soils."

Descriptions of the soil series and mapping units contain some technical terms because there are no nontechnical terms that convey precisely the same meaning. Most of these terms are defined in the Glossary.

Alluvial Land

Alluvial land (0 to 6 percent slopes) (Al) consists of unconsolidated alluvium that was recently deposited by streams. It is on nearly level to gently undulating bottom land that is subject to frequent flooding, scouring, and cutting by streams. In many areas that are dissected by old stream channels, short, narrow ridges impart a corrugated appearance.

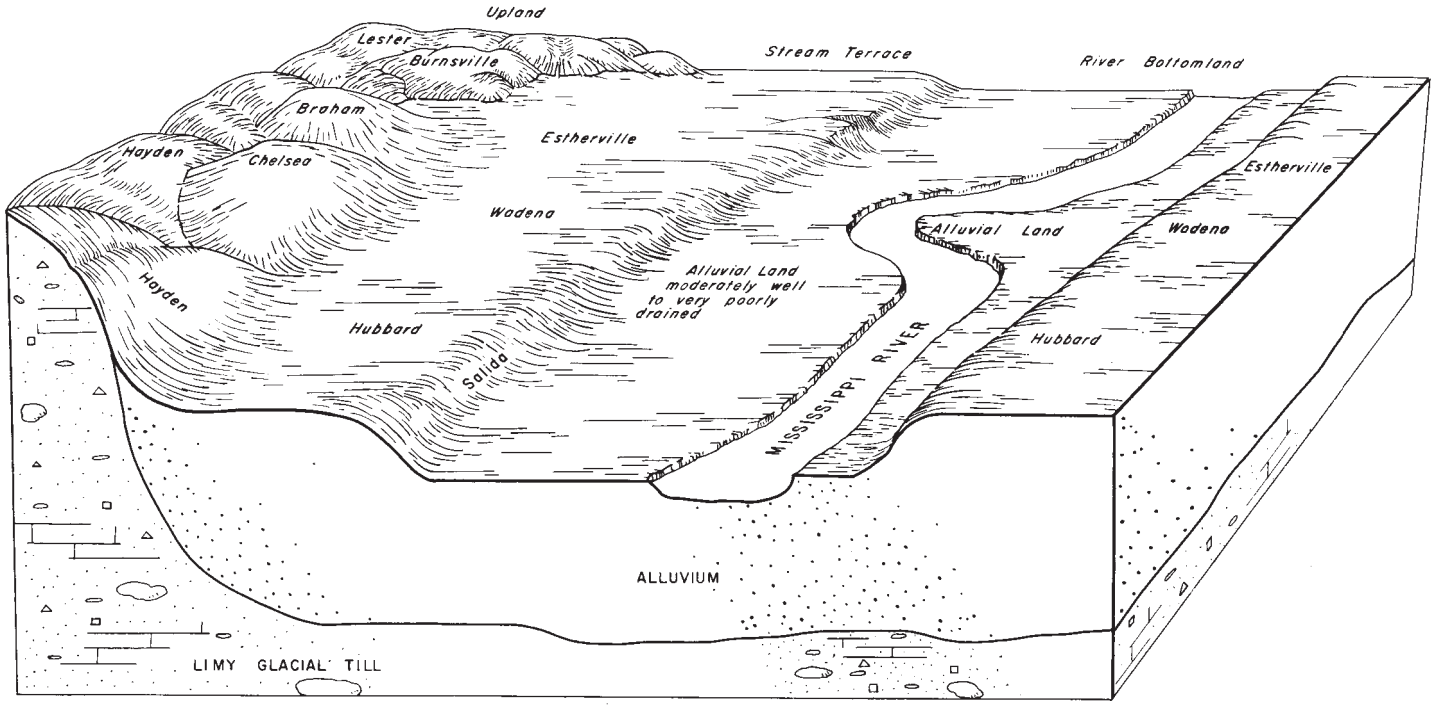

Figure 5.—**Major soils in Wright County on outwash and on bottom lands.**

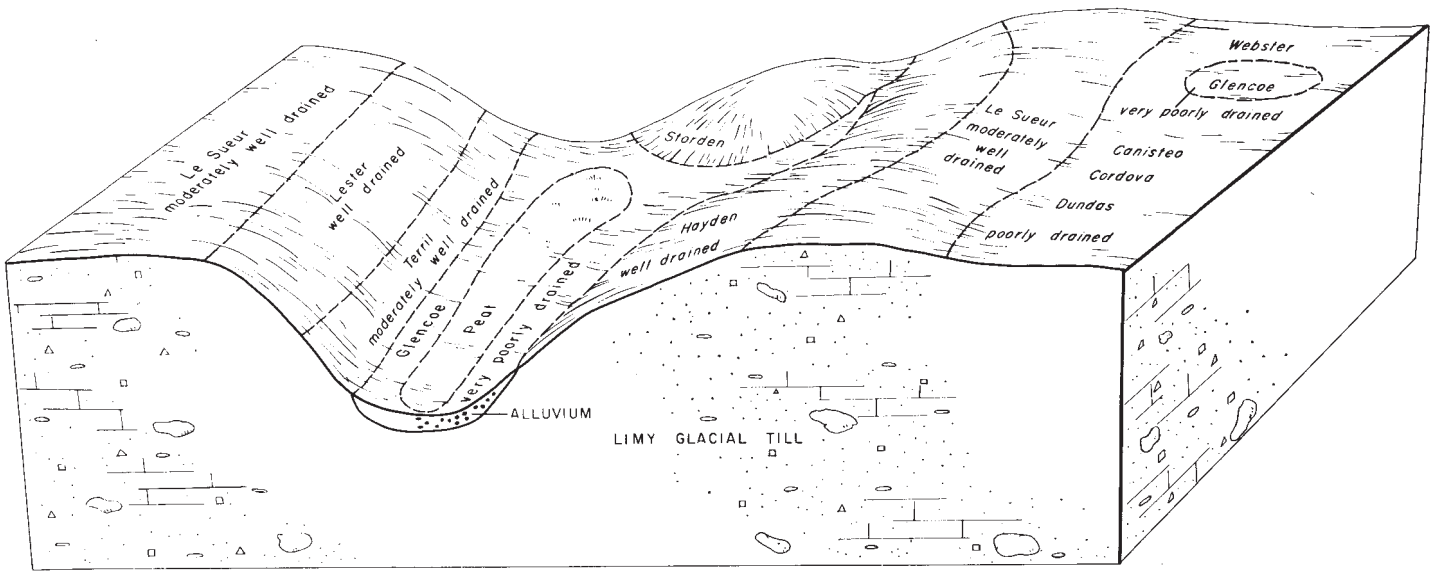

Figure 6.—**Major upland soils in Wright County on limy glacial till.**

The soil materials in this land type range from sand to silty clay loam, but generally are sandy and stratified. Color and reaction also vary.

Alluvial land is dry or only slightly wet between floods. The material is subject to continued change through deposit of new material or through scouring and through shifts in the stream channels. The deposits are so recent that a soil profile has not formed, though the material may be mottled.

Because of the hazard of flooding, most areas of this land type are in unimproved pasture. Capability unit VIw–1; woodland suitability group 11; building site group 11.

Ames Series

Soils of the Ames series are deep, nearly level, and somewhat poorly drained to poorly drained. These soils are in the upland on flats and in areas adjacent to drainageways, mostly in the northeastern part of the county. They are underlain by limy clay loam glacial till at a depth of 24 to 40 inches.

In cultivated fields the plow layer is grayish silt loam about 7 inches thick. Between the plow layer and the subsoil is a layer of lighter gray silt loam about 3 inches thick. The subsoil is olive-brown silty clay about 20 inches thick. It is underlain by olive-gray clay loam. In wooded areas and in some pastures, a dark-gray surface soil less than 3 inches thick overlies a lighter gray subsurface soil about 7 inches thick.

The surface layer of the Ames soils is neutral to medium acid, and the subsoil is slightly acid to very strongly acid. Fertility is moderate, and the content of organic matter is low. Runoff is slow, and the moisture-supplying capacity is high.

Because water moves slowly through these soils, the use of tile to provide drainage for crops is somewhat restricted. Much of the acreage is therefore in pasture or is wooded.

In this county Ames soils occur closely with the Dundas soils and are mapped only in an undifferentiated unit with those soils. A description of the Dundas soils is given under the Dundas series.

Anoka Series

In the Anoka series are nearly level to hilly, somewhat excessively drained soils. These soils are in the upland, generally along stream terraces. They consist chiefly of noncalcareous fine sand, but thin layers of finer textured material are in the substratum.

In cultivated fields the plow layer is dark grayish-brown loamy fine sand about 8 inches thick. The subsurface layer is pale-brown fine sand about 12 inches thick. Below is the substratum, which consists of variable layers of brown fine sand, loamy fine sand, and sandy loam. In wooded areas and in some pastures, the surface layer is dark-gray loamy fine sand that generally is less than 3 inches thick.

These soils are slightly acid to strongly acid to a depth of more than 60 inches, but they are dominantly medium acid. The fertility, moisture-supplying capacity, and content of organic matter are low. Runoff is medium to slow. Water moves rapidly through the sandy surface layer, but the finer textured underlying layers help somewhat in retaining moisture. Because these soils warm up early in spring, crops start growing early. These soils are easy to work, and crops on them respond well if fertilizer is applied.

In this county Anoka soils occur closely with the Braham soils and are mapped only in an undifferentiated mapping unit with those soils. A description of the Braham soils is provided under the Braham series.

Beach Materials, Sandy

Beach materials, sandy (0 to 6 percent slopes) (Ba) consists of sandy beaches that surround present lakes

and the beds of former lakes. The areas vary in width. In places the sandy deposits are on low, narrow ridges or bars that have been pushed up by ice some distance back from the present margin of the lakes.

The soil material that makes up this land type varies, but it generally is dark colored to moderately dark colored coarse sand or loamy coarse sand and lacks distinct layers. Drainage ranges from excessive to somewhat poor. The water table generally is high; its height depends on the season and closeness of the area to a lake. During years when precipitation is high, many areas are submerged. Reaction ranges from slightly alkaline to slightly acid.

This land type generally is low in fertility. Few areas are cropped. The vegetation is sparse stands of grass and willow. Capability unit VIIs–1; woodland suitability group 11; building site group 10.

Becker Series

The Becker series consists of moderately deep, moderately well drained loams underlain by sand and gravel. These soils are on bottom lands along streams. They are subject to occasional flooding, but the water drains away rapidly when the floods subside.

The surface layer of these soils is black loam about 12 inches thick. Below is about 16 inches of very dark grayish-brown loam or sandy loam underlain by dark grayish-brown sand. Depth to sand and gravel generally is between 24 and 36 inches but is as much as 48 inches in places.

Becker soils are neutral to medium acid in the surface layer but are calcareous within a depth of 36 to 72 inches. The fertility and moisture-supplying capacity are moderate, and permeability is moderately rapid. Except for immediately after floods and in wet weather, the water table generally is at a depth of 6 feet or more.

Becker loam to (0 6 percent slopes) (Bb).—This is the only Becker soil mapped in the county. It is mainly in slightly depressional, old stream channels that are now above and some distance from the main stream. Some areas between the old drainageways have short narrow ridges. Depth to sand generally ranges from 24 to 36 inches.

This soil is suited to all crops generally grown in the county. Occasional flooding is the chief hazard. Capability unit IIw–2; woodland suitability group 1; building site group 11.

Biscay Series

In the Biscay series are moderately deep, nearly level, poorly drained soils underlain by limy sand and gravel. These soils are nearly level and are on flats and in drainageways on outwash plains and stream terraces.

The surface layer is black loam about 14 inches thick. The subsoil, a grayish-brown and olive-gray loam, is about 20 inches thick. Olive-gray gravel and sand is at a depth of 24 to 40 inches.

Biscay soils are neutral to mildy alkaline in the surface layer and neutral to moderately alkaline in the subsoil. The fertility is moderately high, and the content of organic matter is high. Runoff is slow, and permeability and moisture-supplying capacity are moderate. Air and water move readily through these soils where they are artificially drained.

Biscay loam (0 to 2 percent slopes) (Bc).—This soil is in nearly level to slightly depressional areas. In a few small areas, the surface soil is moderately alkaline to strongly alkaline.

Drainage is necessary before this soil can be cropped successfully. It is difficult to install and maintain tile drains and open drains because the underlying sandy material tends to cave. If this soil is drained and otherwise well managed, yields of corn and soybeans are good. Undrained areas are used mostly for wild hay and pasture. Capability unit IIw–1; woodland suitability group 10; building site group 9.

Biscay Series, Sandy Subsoil Variant

The variants from the normal Biscay soils are shallow, nearly level, and poorly drained to somewhat poorly drained. These soils are underlain by sand and gravel. They are in small areas on flats and in drainageways on outwash plains and stream terraces.

The surface layer is black loam about 10 inches thick. It is underlain by subsoil of very dark grayish-brown loamy sand that is 4 to 6 inches thick. Olive-gray fine gravel and coarse sand are at a depth of 12 to 24 inches.

These soils are neutral to slightly acid in the surface layer and subsoil. The substratum generally is calcareous within a depth of 72 inches. Fertility is moderate, and the content of organic matter is high. The moisture-supplying capacity is low, but the water table is fairly high and thus helps to replenish moisture. Runoff is slow, and permeability is moderately rapid to rapid.

Biscay loam, sandy subsoil variant (0 to 2 percent slopes) (Bd).—This soil is in slight depressions and drainageways. Most areas are poorly drained. In a few areas that are slightly elevated, the soils are somewhat better drained and have a more brownish subsoil than those in poorly drained areas.

Wetness limits use of this soil for crops, and artificial drainage is difficult to apply or maintain. The sandy underlying material tends to cave, and tile drains generally are not suitable. Broad, shallow surface ditches provide adequate drainage for crops in some places. Areas that are not drained are used chiefly for pasture or wild hay, but in dry seasons they sometimes are cropped. Capability unit IIIw–4; woodland suitability group 10; building site group 9.

Blue Earth Series

Soils of the Blue Earth series are deep and very poorly drained. They are in the shallow basins of former lakes and ponds.

The surface layer, a black silt loam, is about 20 inches thick and is calcareous. It is high in content of organic matter and contains many small snail shells. The subsoil, about 24 inches thick, is black to dark-gray silty clay loam. It is not so limy as the surface soil and contains fewer shells. The underlying material is black to olive-gray, limy silty clay loam.

A thin mantle of limy peat or muck that contains many snail shells generally covers the surface of these soils. In cultivated areas the surface layer generally is fluffy when dry. The surface layer is mildly alkaline to strongly alkaline, and the subsoil is mildly alkaline or moderately alkaline. Fertility is moderate. Runoff is very slow, permeability is moderately slow, and moisture-supplying capacity is high.

Unless these soils are drained, they generally are ponded. In wet years some areas are flooded the year round. Drainage is needed if these soils are cropped.

Blue Earth silt loam (0 to 2 percent slopes) (Be).—This is the only soil in the Blue Earth series mapped in the county. It is mainly in shallow basins of former lakes and ponds, but a few areas border the present lakes and ponds.

Wetness severely limits use of this soil. The low areas are subject to frost. Undrained areas are fair for wild hay or pasture. Drained areas are good for crops and are used mostly for corn for silage. The soil is high in content of lime, and large amounts of potash and phosphate fertilizer are generally needed. Capability unit IIIw–1; woodland suitability group 11; building site group 10.

Braham Series

In the Braham series are moderately deep, nearly level to sloping, sandy soils underlain by glacial till or other relatively fine material. These soils are somewhat excessively drained. They are on upland slopes that border sandy river terraces.

In cultivated fields the plow layer is very dark grayish-brown loamy fine sand about 8 inches thick. The subsoil, a dark grayish-brown to dark-brown fine sand, is about 24 inches thick. It is underlain by dark-brown to olive-brown clay loam. In wooded areas and in some pastures, the surface layer generally is dark-gray loamy fine sand less than 3 inches thick.

These soils are neutral to medium acid in the surface soil and subsoil. The underlying material is also neutral to medium acid, but it generally is calcareous within a depth of 40 to 60 inches. The fertility, content of organic matter, and moisture-supplying capacity are low. Water moves rapidly through the sandy surface layer, but the underlying material is finer textured, and permeability is therefore moderate.

These soils warm up early in spring, and crops on them therefore start growing early. They are easy to work and respond well if fertilizer is added.

In this county Braham soils are mapped only in undifferentiated units with Anoka soils. A description of the Anoka soils is given under the Anoka series.

Braham and Anoka fine sands, 2 to 6 percent slopes, moderately eroded (BhB2).—The soils in this mapping unit have lost from one-fourth to three-fourths of their original surface soil through erosion. The present plow layer is mostly grayish-brown fine sand. A few small depressions are included.

These soils are droughty and are subject to wind erosion. They are fair for small grains and pasture. In most years yields of corn are not good because these soils do not store enough moisture. Capability unit IIIs–3; woodland suitability group 6; building site group 1.

Braham and Anoka fine sands, 6 to 12 percent slopes, moderately eroded (BhC2).—The soils in this mapping unit generally have short, irregular slopes. From one-fourth to three-fourths of the original surface soil has been lost through erosion. The present plow layer is mostly brownish fine sand.

These soils are droughty and are subject to severe erosion. They are poor for crops and pasture. Capability unit IVs–3; woodland suitability group 6; building site group 2.

Braham and Anoka fine sands, 12 to 25 percent slopes (BhD).—The soils in this mapping unit generally have short, irregular slopes. Erosion is only slight in areas of pasture or woods, but in areas that have been cropped, as much as three-fourths of the original surface soil has been washed away through erosion. Here the present plow layer is mostly brownish fine sand.

These soils are droughty and subject to erosion. They are not suited to crops and are only fair for pasture. It is best to keep a permanent cover of vegetation on these soils. Capability unit VIIs–1; woodland suitability group 7; building site group 3.

Braham and Anoka loamy fine sands, 0 to 2 percent slopes (BrA).—The soils in this mapping unit are nearly level in most places, but a few small areas are depressional.

These soils are droughty and are subject to wind erosion. They are fair for small grains and pasture. In most years yields of corn are not good, because these soils do not store enough moisture. Capability unit IIIs–3; woodland suitability group 6; building site group 1.

Braham and Anoka loamy fine sands, 2 to 6 percent slopes (BrB).—These soils have fairly long, smooth slopes in some places, and short, irregular slopes in other places. Small depressions occur in a few areas.

The soils in this mapping unit are droughty and are subject to erosion. They are fair for small grains and pasture. In most years yields of corn are not good, because these soils do not store enough moisture. Capability unit IIIs–3; woodland suitability group 6; building site group 1.

Braham and Anoka loamy fine sands, 6 to 12 percent slopes (BrC).—In this mapping unit are soils that have short, irregular slopes in most places. The areas are mostly in pasture or woods.

These soils are droughty, and there is a severe erosion hazard. They are fair for crops and pasture. Their water-supplying capacity is so low that good crop yields cannot be produced continuously. Capability unit IVs–3; woodland suitability group 6; building site group 2.

Burnsville Series

Soils of the Burnsville series are loamy and are underlain by yellowish, gravelly and sandy, limy glacial till. These soils are nearly level to very steep and hilly and are somewhat excessively drained. They are in the upland, mostly in the northwestern part of the county.

In cultivated fields the surface layer is dark grayish-brown sandy loam or loam about 7 inches thick. The subsoil, a very dark grayish-brown loam or clay loam, is about 10 inches thick. The underlying material, which is at a depth of 10 to 24 inches, is yellowish-brown sand, gravel, and stones. In undisturbed areas the surface layer is very dark brown sandy loam or loam about 3

inches thick. Below is lighter colored, grayish sandy loam or loam 1 to 4 inches thick. Figure 7 shows a profile of Burnsville loam.

The surface soil is slightly acid to medium acid, and the subsoil is slightly acid to strongly acid. The gravelly underlying material is slightly acid to medium acid in places in the upper part, but it is calcareous within a depth of 40 inches. Large stones and boulders generally are on the surface and throughout the profile. The gravelly subsoil limits the rooting zone. Natural fertility and content of organic matter are low, and the moisture-supplying capacity is also low. Runoff is slow to medium on the undulating slopes and medium to rapid on the steeper ones. Air and water move rapidly or very rapidly through these soils.

Burnsville soils, 0 to 6 percent slopes (BuB).—The soils in this mapping unit generally have short, irregular slopes. The surface soil ranges from sandy loam to loam. Depth to sand and gravel ranges from 12 to 24 inches.

In most areas large stones and boulders are on the surface and in these soils. Near Sugar Lake in the northwestern part of the county, however, the soils lack such stones and boulders and are underlain by stratified sand and gravel.

The soils in this unit are droughty and subject to erosion. They are fair for small grains and pasture, but in most years they are too droughty for good yields of corn. Capability unit IIIe–5; woodland suitability group 4; building site group 1.

Figure 7.—**Profile of Burnsville loam; the units on the measure show depth in feet.**

Burnsville soils, 2 to 6 percent slopes, moderately eroded (BuB2).—The soils in this unit generally have short, irregular slopes. From 2 to 4 inches of the original surface soil has been lost through erosion. The present plow layer, a sandy loam and loam, is a mixture of grayish-brown material formerly in the surface soil and of yellowish-brown material formerly in the subsoil. Depth to gravel and sand ranges from 10 to 20 inches.

In a few small areas gravel is on the surface. In most areas large stones and boulders are on the surface and in the soils. Near Sugar Lake in the northwestern part of the county, however, the soils lack such stones and boulders and are underlain by stratified sand and gravel.

Droughtiness and the hazard of further erosion severely limit use. These soils are fair for small grains and pasture, but these are damaged by drought during dry periods. In most years there is not enough moisture for good yields of corn. Capability unit IIIe–5; woodland suitability group 4; building site group 1.

Burnsville soils, 6 to 12 percent slopes (BuC).—Soils in this mapping unit generally have short, irregular slopes. Most areas are in pasture or woods and are only slightly eroded. The surface soil is sandy loam and loam. Depth to sand and gravel ranges from 14 to 24 inches. Small, wet depressions are in areas that have complex slopes.

The soils in this unit are droughty and are subject to severe erosion. They are fair for small grains and pasture, but because of the low moisture-supplying capacity, crops and pasture are damaged by drought during dry periods. The soils are also too droughty for corn in most years. Capability unit IVe–3; woodland suitability group 4; building site group 2.

Burnsville soils, 6 to 12 percent slopes, moderately eroded (BuC2).—Soils in this mapping unit have short, uneven slopes. From one-fourth to three-fourths of the original surface soil has been lost through erosion. The present plow layer is a mixture of grayish-brown loam or sandy loam formerly in the surface soil and of brownish, finer textured material formerly in the subsoil. Depth to sand and gravel ranges from 10 to 18 inches.

In a few places a small amount of gravel is in the surface layer. Some small areas have very irregular slopes and small, wet depressions.

Soils in this unit are subject to severe erosion. They have low moisture-supplying capacity and are droughty. Consequently they are only fair to poor for crops and pasture. Capability unit IVe–3; woodland suitability group 4; building site group 2.

Burnsville soils, 6 to 12 percent slopes, severely eroded (BuC3).—These soils have strong slopes and have lost nearly all of their original surface soil through erosion. The present plow layer is yellowish-brown sandy loam and loam. It is mostly material that was formerly in the subsoil. Depth to gravel and sand is 10 to 14 inches. Many small areas of gravel are on the surface, and there are a few gullies in some areas.

The soils in this unit are droughty. The hazard of further erosion is severe. These soils therefore are not suited to crops and are only fair to poor for pasture. Capability unit VIe–2; woodland suitability group 4; building site group 2.

Burnsville soils, 12 to 18 percent slopes (BuD).—The soils in this mapping unit generally have short, irregular slopes. Much of the acreage is in pasture or woods, and here the soil profile is similar to that described for the series. In cropped areas, however, the soils have lost from one-fourth to three-fourths of their original surface soil through erosion. In these areas the present plow layer is a mixture of grayish-brown sandy loam or loam formerly in the surface soil and brownish, finer textured material formerly in the subsoil. Depth to sand and gravel ranges from 10 to 20 inches, but in cropped areas small spots of gravel generally are on the surface.

Because of slope, the erosion hazard on these soils is severe. In addition low moisture-storage capacity makes the soils droughty. These soils therefore are not suited to crops and are poor for pasture. Capability unit VIe–2; woodland suitability group 5; building site group 3.

Burnsville soils, 12 to 25 percent slopes, severely eroded (BuD3).—Most areas of these soils consist of short, irregular ridges and sharp breaks. Nearly all of the original surface soil has been removed through erosion. The present plow layer is mostly yellowish-brown sandy loam and loam formerly in the subsoil. Depth to sand and gravel ranges from 10 to 14 inches. In many areas small spots of gravel are on the surface. Some areas are cut by gullies of various sizes.

These soils are subject to further erosion and are droughty. Consequently they are not suited to crops and are poor for pasture. A permanent cover of vegetation is best kept on the soils, and careful management is needed. Capability unit VIIe–2; woodland suitability group 5; building site group 3.

Burnsville soils, 18 to 35 percent slopes (BuE).—The soils in this mapping unit are on hills and ridges and the sides of ravines. Most of the acreage is in pasture or woods, and here the profile is like that described for the series. In areas cropped or overgrazed, the soils have lost as much as three-fourths of the original surface soil through erosion. Depth to sand and gravel ranges from 10 to 16 inches.

The slopes, shallowness of the soils over sand and gravel, and the severe hazards of erosion and drought make these soils unsuited to crops and poor for pasture. The areas are best kept under a permanent cover of vegetation. Careful management is also needed. Capability unit VIIe–2; woodland suitability group 5; building site group 3.

Burnsville-Hayden complex, 2 to 6 percent slopes (ByB).—The soils in this complex have short, irregular slopes. Most of the acreage is in pasture or woods. Burnsville sandy loam and loam make up about 55 percent of the acreage, and Hayden fine sandy loam about 25 percent. The remaining 20 percent is Hayden soils and small areas of sand and gravel.

The moisture-supplying capacity of these soils is moderately low, and the hazard of drought is moderate to severe. Nevertheless, these soils are fair for crops and are good for pasture. Capability unit IIIe–5; woodland suitability group 4; building site group 4.

Burnsville-Hayden complex, 2 to 6 percent slopes, moderately eroded (ByB2).—The soils in this complex have short, irregular slopes. About 55 percent of the acreage is Burnsville sandy loam and loam, and about 25 percent is Hayden fine sandy loam. The remaining 20 percent is Hayden loam and small areas of sand and gravel. From one-fourth to three-fourths of the original surface soil has been removed through erosion. The present plow layer, of sandy loam and loam, is a mixture of grayish-brown material formerly in the surface soil and yellowish-brown material formerly in the subsoil.

These soils are fair for crops and pasture, even though the Burnsville soils are droughty and subject to further erosion. Capability unit IIIe–5; woodland suitability group 4; building site group 4.

Burnsville-Hayden complex, 6 to 12 percent slopes (ByC).—The soils in this complex have short, irregular slopes. Most of the acreage is in pasture or woods. About 60 percent of the acreage is Burnsville sandy loam and loam, and about 25 percent is Hayden fine sandy loam. The remaining 15 percent is Hayden loam and small areas of sand and gravel.

The moisture-supplying capacity of these soils is low, and crops and pastures therefore are damaged by lack of moisture in dry periods. The erosion hazard is severe. These soils are poor for crops, but they are fair for pasture. Capability unit IVe–3; woodland suitability group 4; building site group 5.

Burnsville-Hayden complex, 6 to 12 percent slopes, moderately eroded (ByC2).—These soils generally have short, irregular slopes. About 65 percent of the acreage is Burnsville sandy loam and loam, and about 20 percent is Hayden fine sandy loam. The remaining 15 percent is Hayden loam and small areas of sand and gravel. Most of the acreage is in pasture or woods and is only slightly eroded. In cropped areas, however, the soils have lost as much as three-fourths of their original surface soil through erosion.

The soils in this complex are droughty. The erosion hazard is severe. Consequently these soils are not well suited to cultivation. A permanent cover of vegetation is best kept on these soils, and careful management is needed. Capability unit IVe–3; woodland suitability group 4; building site group 5.

Burnsville-Hayden complex, 12 to 18 percent slopes (ByD).—The soils in this complex generally have short, irregular slopes. About 65 percent of the acreage is Burnsville sandy loam and loam, and about 20 percent is Hayden fine sandy loam. The remaining 15 percent is Hayden loam and small areas of sand and gravel. Most of the acreage is in pasture or woods and is only slightly eroded. In cropped areas, however, the soils have lost as much as three-fourths of their original surface soil through erosion.

The soils in this complex are droughty. The erosion hazard is severe. A cover of permanent vegetation is best kept on these soils, and careful management is needed. Capability unit VIe–2; woodland suitability group 5; building site group 6.

Burnsville-Hayden complex, 18 to 35 percent slopes (ByE).—Soils in this complex are mostly on hills and ridges and in ravines. About 70 percent of this complex is Burnsville soils, and the remaining 30 percent is Hayden fine sandy loam and loam. Most of the acreage is in pasture or woods. Areas cropped or overgrazed have lost as much as three-fourths of their original surface soil through erosion.

The hazards of erosion and drought are severe on soils of this complex. It is best to keep a permanent cover of vegetation on the areas. Careful management is also

needed. Capability unit VIIe–2; woodland suitability group 5; building site group 7.

Canisteo Series

The Canisteo series consists of deep, poorly drained, calcareous soils underlain by friable, calcareous clay loam or silty clay loam glacial till. These soils are in level and slightly elevated areas around depressions.

The surface layer of these soils is black silty clay loam about 15 inches thick and generally contains small fragments of snail shells. Below is about 12 inches of very dark gray silty clay loam faintly mottled with olive. The underlying material is olive-gray clay loam glacial till.

Canisteo soils are calcareous throughout the profile. They are high in fertility, content of organic matter, and moisture-supplying capacity. The water table is seasonally high. Runoff and internal drainage are slow. Even though air and water move moderately slowly through these soils, they can be drained effectively with tile.

Canisteo silty clay loam (0 to 2 percent slopes) (Ca).—This is the only Canisteo soil mapped in the county. It is on level and slightly elevated areas around depressions consisting of Glencoe soils and of peaty areas. The profile is like that described for the series. In some places the surface layer has a distinct, light grayish color when dry. Included are small areas of soil that has a strongly calcareous surface layer.

This soil is good for crops and pasture, even though it is wet and calcareous. If tile is used to provide drainage and if fertilizer that contains phosphate and potash is applied and other good management is used, yields of corn and soybeans are good. Capability unit IIw–1; woodland suitability group 10; building site group 9.

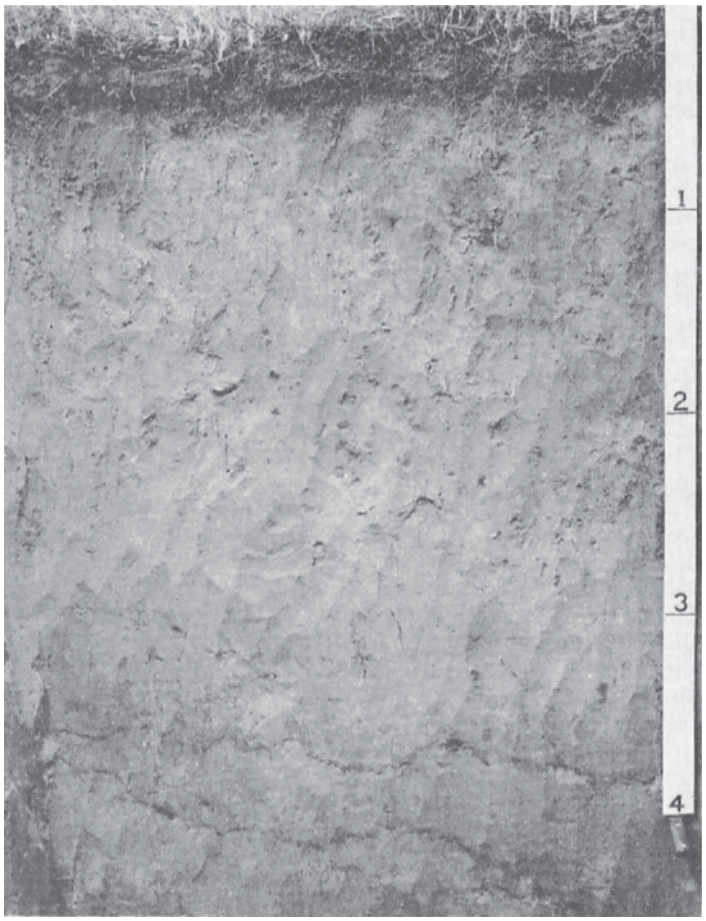

Figure 8.—**Profile of Chelsea fine sand; the units on the measure show depth in feet.**

Chelsea Series

In the Chelsea series are very deep, nearly level to moderately steep, excessively drained fine sands laid down by wind and water. These soils are in the upland along sandy river terraces.

In cultivated fields the plow layer is grayish fine sand about 7 inches thick. The underlying material is brown and yellowish-brown fine sand. In undisturbed wooded and pastured areas, the surface layer is less than 3 inches thick and is very dark gray fine sand. The subsurface layer, which is about 2 inches thick, is grayish-brown fine sand with bleached sand grains. Figure 8 shows a profile of a Chelsea soil.

Chelsea soils are medium acid to strongly acid to a depth of more than 72 inches. The fertility and content of organic matter are low. Runoff is medium to slow. Internal drainage and permeability are rapid. These soils are porous, and air and water move freely through them. They warm up early in spring, dry out quickly after a rain, and are easy to work. The moisture-supplying capacity is low, and the soils are droughty.

Chelsea fine sand, 2 to 6 percent slopes (ChB).—This soil has short, smooth slopes. Most areas are in pasture or woods, which has protected them from erosion. In a few intensively cropped areas, as much as 50 percent of the original surface soil has been removed through wind erosion. The plow layer in these areas is brownish fine sand that has a very low content of organic matter.

This soil is droughty. It is poor for crops and pasture. In exposed areas the soil is likely to be eroded by wind, and in many places young plants are seriously damaged by drifting sand. It is best to keep a permanent cover of vegetation on the areas. Capability unit IVs–1; woodland suitability group 6; building site group 1.

Chelsea fine sand, 6 to 12 percent slopes (ChC).—This soil generally has short, smooth slopes. Most areas are in pasture or woods, which has protected them from erosion. A few areas, however, have been cropped intensively, and here from one-fourth to three-fourths of the original surface soil has been removed through erosion. The plow layer in these eroded areas is brownish fine sand that has a very low content of organic matter.

This soil is droughty and is subject to erosion. It is poor for crops and pasture. A permanent cover of vegetation is best kept on the soil. Capability unit VIs–1; woodland suitability group 6; building site group 2.

Chelsea fine sand, 12 to 18 percent slopes (ChD).—This moderately steep to hilly soil generally has short, irregular slopes. Most areas are in pasture or are in woods, which has protected them from erosion. A few small areas, however, have been cropped, and in these

areas from one-fourth to more than three-fourths of the original surface soil has been lost through erosion. The plow layer in these eroded areas is brownish fine sand that has a very low content of organic matter.

This soil is very droughty and is subject to severe erosion. It is not suited to crops and is poor for pasture. It is best to keep a permanent cover of vegetation on this soil. Capability unit VIIs–1; woodland suitability group 7; building site group 3.

Clayey Basin Land

Clayey basin land (0 to 2 percent slopes) (Cn) consists of deep, poorly drained and very poorly drained clay deposited by water. The largest area is an old lake bottom just southeast of Union Lake in the northwestern part of the county. Small areas also are in drainage channels in sandy outwash plains and in depressions in the glacial uplands.

The surface soil generally ranges from black silty clay loam to silty clay or clay. In most places the subsoil is grayish silty clay or clay to a depth of more than 48 inches. In a few areas, however, the subsoil is silty clay or clay to a depth between 36 and 48 inches and is underlain by silty clay loam or clay loam glacial till. Some ponded areas have at the surface a layer of peat or muck as much as 12 inches thick.

This land type is slightly acid to mildly alkaline in the surface soil and slightly acid to strongly alkaline in the subsoil. Runoff and internal drainage are slow, and permeability is slow to very slow. The water table is seasonally high, and the moisture-supplying capacity is very high. Fertility is high.

In places gypsum crystals are in the substratum of these soils. A few stones and boulders are on the surface in places, but these are seldom in the profile. Air and water move more slowly through the fine-textured subsoil than through the surface soil, and the soils are therefore difficult to drain.

Excess water causes moderate to severe limitations to use of this land type. If this soil is drained and other good management is used, yields of corn and soybeans are good. Undrained areas are used mainly for wild hay. These soils are good sites for ponds that provide water for livestock. Capability unit IIIw–1; woodland suitability group 11; building site group 10.

Comfrey Series

The Comfrey series consists of deep, nearly level, poorly drained, silty soils. These soils are on bottom lands of streams and are subject to variable flooding.

The surface layer is black silty clay loam about 18 inches thick. Below is about 12 inches of very dark gray silty clay loam that is distinctly mottled with olive gray. The underlying material is olive and olive-gray silty clay loam.

In reaction the surface soil ranges from slightly acid to mildly alkaline, but limy sediments generally are at a depth of 24 to 36 inches. Runoff and internal drainage are slow, and permeability is moderately slow. The fertility, moisture-supplying capacity, and content of organic matter are high. The water table is seasonally high. Areas that are protected from floods also need artificial drainage if they are used for crops.

Comfrey silty clay loam (0 to 2 percent slopes) (Co).—This soil is on bottom lands of streams and is subject to frequent flooding. Some areas are dissected in many places by old stream channels. Most of the acreage is in pasture.

Unless this soil is protected from flooding, it is not suited to crops. The areas provide good pasture. Areas protected from flooding also need artificial drainage if they are used for crops. Capability unit VIw–1; woodland suitability group 11; building site group 11.

Comfrey silty clay loam, depressional (0 to 2 percent slopes) (Cp).—This soil is in old stream channels near areas of Comfrey silty clay loam. Because of its lower position on bottom lands of streams, this soil is flooded more frequently than Comfrey silty clay loam and in some seasons is ponded the year round. This soil has a thicker surface layer than that in Comfrey silt loam and generally is more calcareous throughout. In some of the wetter areas the surface layer is covered by a few inches of fibrous peat or muck.

Most areas of this soil are in pasture, willow, and marsh grasses and sedges. Unless protected from flooding and artificially drained, this soil is too wet for cultivation and is not suited to crops. It provides poor pasture. Capability unit VIw–1; woodland suitability group 11; building site group 11.

Cordova Series

Cordova soils are deep and are poorly drained. They are mainly on nearly level, broad areas and in shallow drainageways in the uplands. These soils are underlain by limy clay loam glacial till similar to that underlying the Webster soils.

The surface layer is black silty clay loam about 10 inches thick. Below is about 18 inches of very dark gray and olive-gray silty clay mottled with olive. The underlying material is olive and olive-gray clay loam.

These soils are neutral to slightly acid in the surface soil and slightly acid to strongly acid in the subsoil. Fertility and content of organic matter are high. Runoff and internal drainage are slow, and permeability is moderately slow to slow. The water table is seasonally fairly high, and the moisture-supplying capacity is high.

Even though water moves slowly through these soils, they can be effectively drained with tile. If they are drained and if tilth is maintained, these soils are good for corn and soybeans.

In this county Cordova soils are mapped only in undifferentiated units with Le Sueur or Webster soils. The Le Sueur and Webster soils are described under their respective series.

Cordova and Le Sueur silty clay loams (0 to 3 percent slopes) (Cs).—The soils in this mapping unit are nearly level to very gently sloping. The Le Sueur soil is on slight rises within the soil areas, and the Cordova is on the more nearly level, lower areas. About 60 percent of the acreage is Cordova soil, and the remainder is Le Sueur.

Included with these soils are small areas of Glencoe soils in depressions.

Drainage is needed for economic yields on these Cordova and Le Sueur soils. Tillage also is a problem in wet areas.

If drained and kept in good tilth, these soils are good for corn and soybeans. They are also suitable for small grains and pasture. Capability unit IIw–1; woodland suitability group 10; building site group 9.

Cordova and Webster silty clay loams (0 to 2 percent slopes) (Cw).—This mapping unit is in nearly level areas and in shallow drainageways. The Cordova soil is the most extensive and occupies most of the nearly level, broad areas.

Included with these soils in mapping are some small areas of Glencoe soils in depressions.

These Cordova and Webster soils require drainage for economic yields. If these soils are drained and kept in good tilth, yields of corn and soybeans are good. The soils are also suitable for small grains and pasture. Capability unit IIw–1; woodland suitability group 10; building site group 9.

Duelm Series

The Duelm series consists of somewhat poorly drained sandy loams underlain by sand and gravel. These soils are in shallow depressions and drainageways in outwash plains and stream terraces.

The surface layer is black sandy loam about 14 inches thick. Below is about 6 inches of very dark grayish-brown sandy loam. This is underlain by dark grayish-brown loamy sand that grades to deep deposits of olive-brown sand at a depth of 26 inches. The substratum is mainly sand and is at a depth of 24 to 42 inches.

Duelm soils are neutral to medium acid to a depth of more than 48 inches. The fertility and moisture-supplying capacity are moderate. Runoff and internal drainage are medium to slow, and permeability is moderately rapid to rapid. The water table is seasonally fairly high.

In this county Duelm soils are mapped only in an undifferentiated unit with Watseka soils. A description of the Watseka soils is given under the Watseka series.

Duelm and Watseka soils (0 to 2 percent slopes) (De).—This mapping unit is in shallow depressions and drainageways in sandy areas. In a few places a thin layer of loam has been washed onto the soils from areas above. Also thin, variable layers of loamy sand or sandy loam are in the sandy underlying material in a few places. The Watseka soils are sandy and are somewhat better drained than the Duelm. Duelm soils occupy the largest acreage in this mapping unit.

Because of the fairly high seasonal water table, these soils remain moist throughout most of the growing season and are suitable for crops and pasture. Drainage is a problem in wet years, however, and during prolonged dry spells the soils are somewhat droughty. Capability unit IIIw–4; woodland suitability group 10; building site group 8.

Dundas Series

Dundas soils are deep, nearly level, and somewhat poorly drained and poorly drained. They are on small flats adjacent to drainageways in the upland. These soils are underlain by limy clay loam glacial till at a depth of 30 to 40 inches.

In cultivated fields the plow layer is very dark gray silt loam about 7 inches thick. The subsoil is dark grayish-brown and olive-gray silty clay that is mottled with olive and is about 28 inches thick. The underlying material is olive and olive-gray clay loam. In undisturbed wooded and pastured areas, the surface soil is black silt loam about 4 inches thick and the subsurface layer is a grayish silt loam about 3 inches thick.

The surface layer of these soils is neutral to medium acid, and the subsoil is slightly acid to very strongly acid. The fertility and content of organic matter are moderate. Runoff and internal drainage are slow, and permeability is moderately slow to slow. The moisture-supplying capacity is high, and the water table is seasonally fairly high.

Because water moves slowly through these soils, the use of tile to provide drainage for crops is somewhat restricted. Much of the acreage is therefore in pasture or is wooded.

Dundas silt loam (0 to 3 percent slopes) (Dn).—This soil is in areas that have slight rises and shallow depressions.

Included with this soil are some small areas of Glencoe soils in deeper depressions.

This Dundas soil is fair to good for crops and good for pasture, but wetness is a problem. Artificial drainage is needed, though water moves slowly through the fine-textured subsoil and hinders drainage. Special practices are needed to improve the efficiency of drainage systems and to produce good yields. Capability unit IIIw–2; woodland suitability group 10; building site group 9.

Dundas and Ames silt loams (0 to 3 percent slopes) (Du).—This mapping unit is mostly in the northeastern part of the country. The soils are nearly level, and the areas have many low ridges and shallow depressions.

Dundas soil makes up more than 60 percent of this mapping unit. It has a thicker surface layer than the Ames soil. In plowed areas the surface layer of both soils is grayish in color.

Included with these soils in mapping are small wet areas of Glencoe soils in depressions.

These Dundas and Ames soils are fair to good for crops and good for pasture, but wetness is a problem. Artificial drainage is needed, though water moves slowly through the fine-textured subsoil and hinders drainage. Special cropping practices are needed to improve the efficiency of drainage systems and to produce good yields. Capability unit IIIw–2; woodland suitability group 10; building site group 9.

Emmert Series

The Emmert series consists of rolling to very steep, somewhat excessively drained and excessively drained soils. These soils are underlain by acid, gravelly and sandy drift. They are in the uplands, mostly in Silver Creek Township in the north-central part of the county. Slopes are irregular.

In cultivated areas the plow layer is dark grayish-brown sandy loam, about 7 inches thick. The subsoil, a dark-brown loamy sand, is about 10 inches thick. The underlying material is reddish-brown sand, gravel, and stones. In undisturbed wooded and pastured areas, the surface soil is black sandy loam and generally is no more

than 4 inches thick. Large stones and boulders are on and in the soils in many places.

The profile of these soils, as well as the underlying material, is slightly acid to medium acid. In places the underlying material is reddish, acid drift or is mixed with yellowish, limy drift. In a few places a smear of reddish drift overlies the yellowish drift.

The fertility and content of organic matter are low in the Emmert soils. Runoff is slow to medium on the rolling areas and medium to rapid on the more strongly sloping ones. Internal drainage and permeability are rapid or very rapid. The moisture-supplying capacity ranges from low to very low, depending on the texture of the soils and the depth to gravel and sand.

Large areas of Emmert soils are in pasture or woods. The soils are droughty, and their use for crops is limited.

In this county Emmert soils are mapped only in complexes with Milaca soils. A description of the Milaca soils is given under the Milaca series.

Emmert-Milaca complex, 2 to 6 percent slopes (EmB).—This complex consists of soils that have short, irregular slopes. About 55 percent is Emmert sandy loam, and about 25 percent is Milaca loam. The remaining 20 percent is Emmert gravelly sandy loam and small areas of gravel and sand. Areas in trees and pasture have been protected from erosion, but most areas in crops have lost from one-fourth to three-fourths of the original surface soil through erosion.

These soils are fair to poor for crops and fair for pasture. They are mostly droughty. The erosion hazard is severe. Capability unit IIIe–5; woodland suitability group 4; building site group 4.

Emmert-Milaca complex, 6 to 12 percent slopes (EmC).—This complex consists of rolling soils that have short, irregular slopes. About 60 percent is Emmert sandy loam, and about 20 percent is Milaca loam. The remaining 20 percent is Emmert gravelly sandy loam, which generally is on the more abrupt slopes. Areas in pasture and woods are only slightly eroded. Most areas in crops have lost from one-fourth to three-fourths of the original surface soil through erosion. A few areas are severely eroded, and some of these have deep gullies. In these areas the present plow layer is mostly brownish sandy material formerly in the subsoil, and in many places spots of gravel are on the surface.

These soils are mostly poor for crops and pasture. They are too droughty for row crops, and the erosion hazard is severe. Severely eroded areas are best kept under a permanent cover of vegetation. Capability unit IVe–3; woodland suitability group 4; building site group 5.

Emmert-Milaca complex, 12 to 18 percent slopes (EmD).—This complex consists of soils on irregular ridges and knolls. About 45 percent is Emmert gravelly sandy loam, and about 35 percent is Emmert sandy loam. The remaining 20 percent is Milaca loam. Most areas are in pasture or woods and are only slightly eroded. Areas in crops have lost as much as three-fourths of the original surface soil through erosion. A few areas are severely eroded, and some of these have deep gullies. In these places the present plow layer is mostly brownish gravelly material formerly in the subsoil.

Severe drought and erosion hazards make these soils unsuitable for crops. It is best to keep the areas under a permanent cover of vegetation. Capability unit VIe–2; woodland suitability group 5; building site group 6.

Emmert-Milaca complex, 18 to 35 percent slopes (EmE).—Soils in this complex are on ridges and sides of ravines. About 65 percent is Emmert gravelly sandy loam, and about 20 percent is Emmert sandy loam. The remaining 15 percent is Milaca loam. Most areas are in pasture or woods and are only slightly eroded. A few small areas in crops have lost as much as one-half of the original surface soil through erosion. Also a few small areas are severely eroded. In these areas nearly all of the original surface soil has been removed through erosion, and in places there are deep gullies.

The hazards of erosion and drought are very severe on these soils. It is best to keep the areas under a permanent cover of vegetation. Careful management is also needed. Capability unit VIIe–2; woodland suitability group 5; building site group 7.

Estherville Series

In the Estherville series are shallow, nearly level to strongly sloping and hilly soils that are somewhat excessively drained. These soils are mainly on outwash plains and stream terraces. They are underlain by calcareous sand and gravel at a depth of 10 to 24 inches.

The surface layer is black sandy loam about 9 inches thick. The subsoil, a dark-brown sandy loam or weak loam, is about 10 inches thick. Below is dark yellowish-brown, stratified sand and gravel that was laid down by water (fig. 9). In places in the townships of South Side, Corinna, and Clearwater in the northwestern part of the county, the surface layer is thinner and lighter colored than that in other Estherville soils in the county. In these places scrub oaks encroached on areas of prairie grass.

Estherville soils range from slightly acid to medium acid in the surface soil and subsoil. The underlying material generally is calcareous within a depth of 36 inches. Fertility is moderately low to low. Runoff is medium, and internal drainage and permeability are rapid. The moisture-supplying capacity is low.

Because air and water move easily through these soils, they warm up early in spring. Lack of moisture and a limited root zone make the soils droughty and generally limit use. These soils are a good source of gravel, and many gravel pits are in the areas.

Estherville loam, 0 to 2 percent slopes (EsA).—This soil has a surface soil and subsoil of loam. Depth to gravel and sand generally is 18 to 24 inches. In a few places a thin layer of wind-drifted, sandy material covers the surface.

Low moisture-supplying capacity limits use of this soil. This soil is good for small grains and pasture, but in most years it is too droughty for good yields of corn. Capability unit IIIs–2; woodland suitability group 4; building site group 1.

Estherville loam, 2 to 6 percent slopes (EsB).—This soil has short, smooth slopes. It has a surface soil and subsoil of loam. Depth to gravel and sand generally is 18 to 24 inches.

Low moisture-supplying capacity limits use of this soil. This soil is good for small grains and pasture, but in most years it is too droughty for good yields of corn. Capabil-

Figure 9.—**Profile of Estherville sandy loam showing the stratified underlying sand and gravel. The rule extends to a depth of 4 feet.**

ity unit IIIe–5; woodland suitability group 4; building site group 1.

Estherville loam, 2 to 6 percent slopes, moderately eroded (EsB2).—In most places this soil has short complex slopes. From 3 to 6 inches of the original surface soil has been lost through erosion. The present plow layer, a mixture of the remaining surface soil and of material formerly in the subsoil, is grayish-brown loam. Depth to gravel and sand generally is 16 to 20 inches.

The hazards of drought and erosion are severe on this soil and limit its use. This soil is fair for small grains and pasture, but in most years lacks sufficient moisture for good yields of corn. Capability unit IIIe–5; woodland suitability group 4; building site group 1.

Estherville loam, 6 to 12 percent slopes (EsC).—This soil generally has short, uneven slopes. Most of of the acreage is in pasture or woods, and these areas are only slightly eroded. The surface soil and subsoil are loam. Depth to gravel and sand generally is 16 to 20 inches.

This soil is droughty. It is subject to erosion if cropped. It is good for small grains and pasture, but in most years it lacks sufficient moisture for good yields of corn. Capability unit IVe–3; woodland suitability group 4; building site group 2.

Estherville loam, 6 to 12 percent slopes, moderately eroded (EsC2).—This soil generally has short, irregular slopes. Erosion has washed away from 3 to 6 inches of the original surface soil. The present plow layer, a mixture of the remaining surface soil and of material formerly in the subsoil, is grayish-brown loam. Depth to gravel and sand generally is 16 to 18 inches. In a few small areas spots of gravel are on the surface.

Drought and erosion are severe hazards on this soil. This soil is fair for small grains and pasture, but corn generally dries up before it can mature. Capability unit IVe–3; woodland suitability group 4; building site group 2.

Estherville sandy loam, 0 to 2 percent slopes (EtA).—This soil has a thin layer of wind-drifted sand on the surface in places. Depth to gravel and sand generally is 16 to 20 inches.

This soil is droughty and is subject to wind erosion. It is fair for small grains and pasture, but because of low moisture-supplying capacity, it is poor for corn. Capability unit IIIs–2; woodland suitability group 4; building site group 1.

Estherville sandy loam, 2 to 6 percent slopes (EtB).—This soil has a thin layer of wind-drifted sandy material on the surface in places. Depth to gravel and sand generally is 16 to 20 inches.

This soil is fair for small grains and pasture. It is poor for corn, which is damaged by drought because the supply of moisture in the soil is low. Erosion is also a serious problem. Capability unit IIIe–5; woodland suitability group 4; building site group 1.

Estherville sandy loam, 2 to 6 percent slopes, moderately eroded (EtB2).—This soil has lost 3 to 6 inches of its original surface soil through erosion. The present plow layer, a grayish brown sandy loam, is a mixture of the remaining surface soil and of material formerly in the subsoil. Depth to gravel and sand generally is 14 to 16 inches. In a few small areas spots of gravel are on the surface.

Low moisture-supplying capacity and the hazard of erosion severely limit use of this soil. This soil is fair for small grains and pasture, but because of droughtiness, it is poor for corn. Capability unit IIIe–5; woodland suitability group 4; building site group 1.

Estherville sandy loam, 6 to 12 percent slopes (EtC).—This soil has short, irregular slopes. Most areas have been used for pasture or woods and are little eroded. Depth to gravel and sand generally is 15 to 18 inches

Because of the severe hazards of drought and erosion, this soil is poor for corn. It is fair, however, for small grains and pasture. Capability unit IVe–3; woodland suitability group 4; building site group 2.

Estherville sandy loam, 6 to 12 percent slopes, moderately eroded (EtC2).—This soil has short, uneven slopes. From 3 to 6 inches of the original surface soil has been lost through erosion. The present plow layer, a grayish-brown sandy loam, is a mixture of the remaining surface soil and of material formerly in the subsoil. Depth to gravel and sand generally is 14 to 16 inches, but in a few small areas spots of gravel are on the surface.

This soil is droughty, and the hazard of further erosion is severe. It is fair for small grains and pasture but poor for corn. Capability unit IVe–3; woodland suitability group 4; building site group 2.

Estherville sandy loam, 12 to 18 percent slopes (EtD).—This soil has short, irregular slopes. Areas in pasture or woods are little eroded, but most areas that have been

cropped have lost as much as 6 inches of their original surface soil. Depth to gravel and sand ranges from 12 to 20 inches. Cropped areas generally have spots of gravel on the surface.

This soil is droughty, and the hazard of erosion is severe. It is not suited to crops and is only fair for pasture. Capability unit VIe–2; woodland suitability group 5; building site group 3.

Estherville sandy loam, 18 to 25 percent slopes (EtE).—This hilly soil is mostly in woods or pasture and is little eroded. In cropped areas the soil has lost as much as 6 inches of its original surface soil. The surface layer is dominantly sandy loam, but in a few areas it is loam.

Because of the strong slopes and the shallowness of the soil to underlying gravel and sand, the hazards of erosion and drought are very severe. It is best to keep a cover of permanent vegetation on this soil. Careful management is also needed. Capability unit VIIe–2; woodland suitability group 5; building site group 3.

Estherville soils, 6 to 12 percent slopes, severely eroded (EvC3).—Nearly all of the original surface layer of these rolling soils has been washed away through erosion. Some areas also have gullies of various sizes. The present plow layer is brownish sandy loam or loam and consists mostly of material formerly in the subsoil. Depth to gravel and sand generally is 10 to 14 inches. In some small areas spots of gravel are on the surface.

These soils are very droughty and are subject to further erosion. They are not suited to crops and are poor for pasture. Capability unit VIe–2; woodland suitability group 4; building site group 2.

Estherville soils, 12 to 25 percent slopes, severely eroded (EvE3).—Much of the acreage of these soils was cropped at some time. As a result nearly all of the original surface soil has been removed through erosion. In places there are many gullies. The present plow layer is brownish sandy loam or loam and is mostly material that formerly was in the subsoil. Depth to gravel and sand generally is 10 to 24 inches.

These soils are droughty and are subject to further erosion. They are not suited to crops and are poor for pasture. A permanent cover of vegetation is best kept on the areas. Capability unit VIIe–2; woodland suitability group 5; building site group 3.

Fairhaven Series

In the Fairhaven series are moderately deep, nearly level to rolling, well-drained, silty soils. These soils are on outwash plains and stream terraces, mostly in the northwestern part of the county. They are underlain by calcareous sand and gravel at a depth of 24 to 42 inches.

The surface layer is black silt loam about 9 inches thick. The subsoil, a dark grayish-brown to yellowish-brown silt loam, is about 15 inches thick. Below is yellowish and grayish-brown sand and gravel.

These soils have a surface layer that is neutral to slightly acid. The subsoil is slightly acid to medium acid. In places the underlying sand and gravel is leached of free lime in the upper part but is calcareous within a depth of 40 inches. Fertility is high. Runoff and internal drainage are medium, and permeability is moderately rapid. The moisture-supplying capacity is moderate, and these soils are slightly droughty during prolonged dry periods.

Fairhaven silt loam, 0 to 2 percent slopes (FaA).—The profile of this soil is similar to the one described for the series, but depth to sand and gravel generally is 24 to 36 inches.

This soil is good for crops and pasture, but it is slightly droughty during prolonged dry periods. Capability unit IIs–1; woodland suitability group 1; building site group 1.

Fairhaven silt loam, 2 to 6 percent slopes (FaB).—This soil has smooth, fairly long slopes. Depth to sand and gravel generally is 24 to 30 inches.

Because of the slopes, this soil is subject to erosion. It is good for crops and pasture, but the yields of corn are limited because of the moderate moisture-supplying capacity. Capability unit IIe–4; woodland suitability group 1; building site group 1.

Fairhaven silt loam, 2 to 6 percent slopes, moderately eroded (FaB2).—This soil has smooth, fairly long slopes. It has lost from 3 to 6 inches of its original surface soil through erosion. Plowing has mixed material formerly in the subsoil with the remaining surface soil to form the present brownish plow layer. Depth to sand and gravel is 24 to 30 inches.

This soil is droughty. It is fair to good for small grains and pasture, but in most years there is not enough moisture for good yields of corn. Practices are needed that control erosion and thus keep the soil from becoming more droughty. Capability unit IIe–4; woodland suitability group 1; building site group 1.

Fairhaven silt loam, 6 to 12 percent slopes, moderately eroded (FaC2).—This soil has fairly long smooth slopes. From 3 to 6 inches of its original surface soil has been removed through erosion. Plowing has mixed material formerly in the subsoil with the remaining surface soil to form the present brownish plow layer. Depth to sand and gravel is 24 to 30 inches. A few areas are in woods or pasture and are little eroded.

This soil is fair for small grains and pasture, but it generally lacks sufficient moisture for good yields of corn. Practices are needed that control erosion and thus keep the soil from becoming more droughty. Capability unit IIIe–3; woodland suitability group 2; building site group 2.

Glencoe Series

In the Glencoe series are deep, very poorly drained soils underlain by limy clay loam or silty clay loam glacial till. These soils are in depressions and drainageways in the upland.

The surface soil is black silty clay loam about 21 inches thick, and the subsoil is very dark gray and olive-gray silty clay loam about 15 inches thick. Below is olive-gray clay loam or silty clay loam. In many places a thin layer of peat or muck covers the surface. Also in many places material of varying depth has been washed onto these soils from surrounding higher areas.

In reaction the surface soil and subsoil range from slightly acid to mildly alkaline. Limy underlying material generally is within a depth of 48 inches. The fertility and content of organic matter are high. The seasonal water table and moisture-supplying capacity are also high. Runoff is very slow to ponded. Internal

drainage is slow, and permeability is moderately slow.

Even though movement of water through these soils is moderately slow, they can be effectively drained with tile. Unless drained, these soils are periodically ponded, and in wet years some areas are flooded the year round.

Glencoe silty clay loam (0 to 2 percent slopes) (Gc).—This is the only Glencoe soil mapped in the county. It is in depressions and drainageways.

Included with this soil are a few areas of a soil that has a calcareous surface soil.

Excess water severely limits use of this Glencoe soil. Undrained areas are poor for wild hay or pasture, and artificial drainage is necessary if this soil is cropped. Drained areas are good for corn and soybeans, but crops on them are susceptible to damage by frost. Capability unit IIIw–1; woodland suitability group 11; building site group 10.

Guckeen Series

The Guckeen series consists of deep, nearly level and gently sloping, moderately well drained and somewhat poorly drained soils. These soils consist of silt and clay laid down in water. They are in the lake region in the northwestern part of the county.

The surface layer is black silty clay loam about 12 inches thick. The subsoil, a dark grayish-brown to light olive-brown silty clay, is about 36 inches thick. Below is light olive-brown silty clay loam.

These soils have a surface soil that is neutral to slightly acid and a subsoil that is medium acid to very strongly acid. Alkaline underlying material generally is at a depth of about 48 inches. The fertility and moisture-supplying capacity are moderate. Runoff and internal drainage are medium, and permeability is moderately slow to slow.

The fine-textured subsoil somewhat restricts movement of air and water through these soils. Nevertheless these soils are good for crops if well managed.

Guckeen silty clay loam, 0 to 2 percent slopes (GuA).—In a few places this soil has a surface layer of silt loam, but its profile otherwise is similar to the profile described for the series.

This soil is good for crops and has few limitations in use. If tilth is maintained and the supply of plant nutrients is replenished and other good management is used, yields are good. Capability unit I–1; woodland suitability group 1; building site group 8.

Guckeen silty clay loam, 2 to 6 percent slopes (GuB).—This soil has smooth, gentle slopes. Its profile is similar to the one described for the series, but because of the slope, runoff is somewhat better.

Included with this soil are a few small areas that have a surface layer of silt loam. Also included are a few areas underlain by sand at a depth of 40 inches or more.

If this Guckeen soil is well managed, it is good for the crops generally grown in the county. Maintaining the soil in good tilth is a problem, and the soil also erodes readily. Capability unit IIe–1; woodland suitability group 1; building site group 8.

Guckeen silty clay loam, 6 to 12 percent slopes (GuC).—This soil has fairly long, smooth slopes. A few areas are in woods or pasture and are little eroded. Most areas, however, are cropped and have lost about 3 inches of their original surface soil through erosion. In these areas the plow layer is dark grayish-brown heavy silty clay loam, which is difficult to till. Runoff is faster than for the profile described for the series, and water moves slowly through the fine-textured subsoil.

This soil is subject to severe erosion if it is cultivated and not protected. It is suitable for crops, however, and is good for pasture. Capability unit IIIe–1; woodland suitability group 2; building site group 8.

Hayden Series

The Hayden series consists of deep, nearly level to very steep, well-drained soils. These soils are extensive on undulating to hilly areas in the upland. Slopes are irregular and generally are complex. Hayden soils generally are underlain by limy loam or clay loam glacial till at a depth of 30 to 36 inches.

The plow layer is dark grayish-brown loam about 7 inches thick. Just below is a somewhat lighter gray loam, about 3 inches thick, that grades to dark grayish-brown clay loam at a depth of about 20 inches. The underlying material is olive-brown loam or clay loam. In undisturbed areas the surface layer is very dark gray and is 2 to 4 inches thick. Below is 3 to 6 inches of lighter gray subsurface soil. A profile of a Hayden loam is shown in figure 10.

Hayden soils have a slightly acid surface layer and a slightly acid to strongly acid subsoil. Fertility is moderate. Runoff is medium to rapid, depending on the steepness of the slope. Internal drainage is medium, and permeability is moderate. Moisture-supplying capacity is moderate to moderately high. The content of organic matter is low; nevertheless, these soils are productive if well managed.

Hayden clay loam, 6 to 12 percent slopes, severely eroded (HaC3).—This soil has lost nearly all of its original surface soil through erosion. The present plow layer is a brownish clay loam and consists mostly of material formerly in the subsoil. Depth to limy underlying material generally is about 30 inches. In a few places small gullies occur.

Because of erosion the content of organic matter in this soil is low, and thus infiltration of water is reduced and the supply of moisture lowered. In years of low rainfall this soil therefore is likely to be droughty. This soil also is in poor tilth, and cultivating it and preparing a seedbed in it is difficult.

This soil is poor for crops but is fair for pasture. It is subject to further erosion, and it therefore is not suitable for continuous cultivation. Capability unit IVe–1; woodland suitability group 2; building site group 5.

Hayden clay loam, 12 to 18 percent slopes, severely eroded (HaD3).—This soil has lost nearly all of its original surface soil through erosion. The present plow layer is brownish clay loam and consists mostly of material that formerly was in the subsoil. Depth to limy underlying material is 24 to 36 inches. In places there are a few small gullies.

Mapped with this soil are a few areas of a soil where the plow layer is sandy clay loam and contains small pockets of sand. Also included are small areas of Glencoe and Webster soils in depressions in between complex slopes.

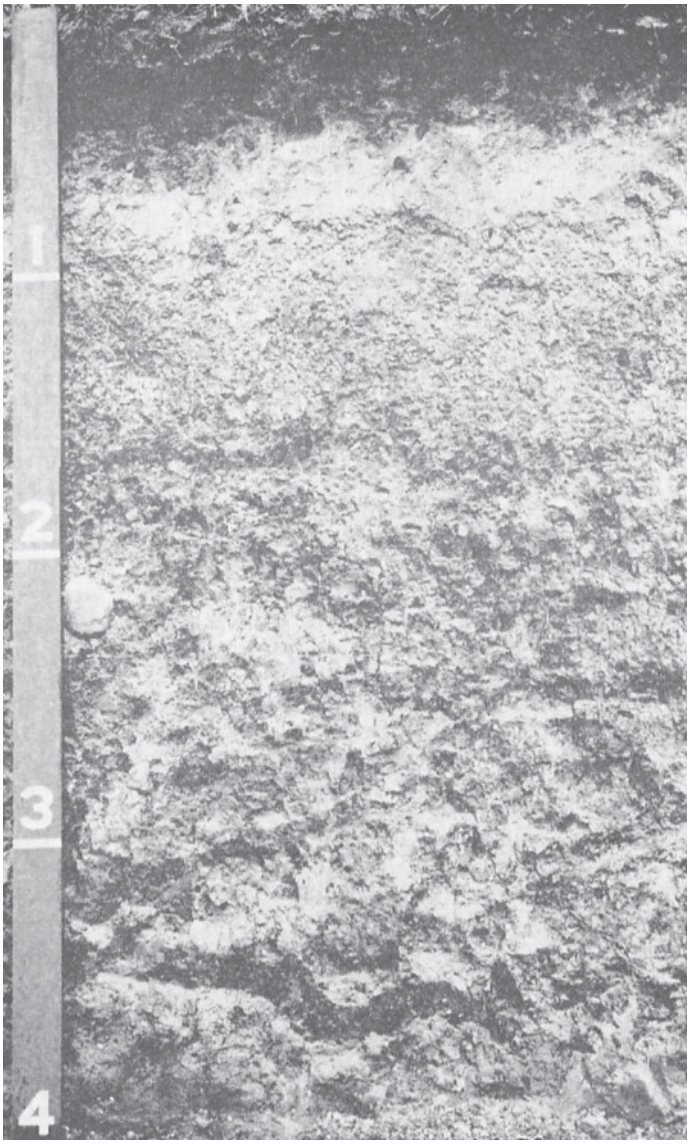

Figure 10.—**Profile of a Hayden loam; the units on the measure show depth in feet.**

Because of erosion the content of organic matter in this Hayden soil is low, and thus infiltration of moisture is reduced and the supply of moisture is lowered. In years of low rainfall, this soil therefore is likely to be slightly droughty. This soil also is in poor tilth. Crusting makes it difficult to cultivate the soil and to prepare a seedbed. The hazard of further erosion is very severe.

This soil is not suitable for cultivation. It is best kept under a permanent cover of vegetation. Capability unit VIe–1; woodland suitability group 2; building site group 6.

Hayden fine sandy loam, 0 to 2 percent slopes (HdA).—Except that the surface soil is fine sandy loam and the upper part of the subsoil is more sandy, the profile of this soil is similar to the one described for the series.

Mapped with this soil are small areas of a soil that contains pockets of sand or loamy sand and that has a finer textured subsoil at a depth of less than 18 inches.

This Hayden soil is subject to wind erosion. The moisture-supplying capacity is moderate, and in periods of low rainfall, crops are damaged slightly by drought. This soil is nevertheless good for crops and pasture. Capability unit IIe–3; woodland suitability group 1; building site group 4.

Hayden fine sandy loam, 2 to 6 percent slopes (HdB).—This soil generally has short, irregular slopes. Its subsoil is more sandy in the upper part than that in the profile described for the series.

Mapped with this soil are small areas of a soil that contains pockets of sand or loamy sand and that has a finer textured subsoil within a depth of 18 inches. Also included are small areas in depressions between complex slopes.

This Hayden soil is fair to good for crops and pasture. It is sandy and is low in content of organic matter. Consequently the moisture-supplying capacity is somewhat restricted, and in most years crops lack sufficient moisture for good yields. Even though the slopes are mild, this soil is subject to erosion, and practices for the control of erosion are needed. Capability unit IIe–3; woodland suitability group 1; building site group 4.

Hayden fine sandy loam, 2 to 6 percent slopes, moderately eroded (HdB2).—This soil generally has short, uneven slopes. The subsoil is more sandy in the upper part than that in the profile described for the series. Plowing has mixed material from the subsoil with the remaining surface soil to form the present plow layer of grayish-brown fine sandy loam.

Mapped with this soil are small areas that have a thin layer of sand or loamy sand on the surface and a finer textured subsoil within a depth of 18 inches. In areas where the slopes are very irregular, small areas of poorly drained soils are between the slopes.

This Hayden soil is fair to good for crops and pasture. It is sandy and its content of organic matter is low. Consequently it is slightly droughty and is subject to erosion. Nevertheless if this soil is well managed, yields are good. Capability unit IIe–3; woodland suitability group 1; building site group 4.

Hayden fine sandy loam, 6 to 12 percent slopes (HdC).—Most of this soil is in woods or pasture. Slopes generally are short and irregular. The subsoil is more sandy in the upper part than that in the profile described for the series.

Mapped with this soil are small areas that have a surface soil of sand and gravel and a finer textured subsoil. In areas where the slopes are very complex are small areas of Webster or Glencoe soils in depressions between the slopes.

This Hayden soil is fair for crops and pasture. It is slightly droughty, but if it is well managed, yields are good. Because this soil is sandy and has strong slopes, it is subject to severe erosion. Capability unit IIIe–2; woodland suitability group 2; building site group 5.

Hayden fine sandy loam, 6 to 12 percent slopes, moderately eroded (HdC2).—This soil has lost 3 to 6 inches of its original surface soil through erosion. The present plow layer is grayish-brown fine sandy loam. The subsoil is more sandy than that in the profile described for the series.

Mapped with this soil are some small areas of sand and gravel. In areas where the slopes are irregular, small

areas of Glencoe and Webster soils are in depressions between the slopes.

This Hayden soil is well suited to pasture but not so well suited to crops. It is sandy, and its content of organic matter is low. The moisture-supplying capacity is therefore limited, and productivity is lowered. The hazard of further erosion is severe if these soils are cultivated and not protected. Capability unit IIIe–2; woodland suitability group 2; building site group 5.

Hayden fine sandy loam, 12 to 18 percent slopes (HdD).—Most of this soil is in woods or pasture. Its subsoil is somewhat more sandy in the upper part than that in the profile described for the series.

Included with this soil are small areas that have a surface layer of sand and gravel and a finer textured subsoil. In areas where the slopes are very complex are Glencoe or Webster soils in small depressions.

This Hayden soil is fair for crops and good for pasture. It is sandy, has moderately steep slopes, and lacks sufficient moisture for increased yields. Also the hazard of erosion is severe, and intensive practices are needed to prevent further erosion. Capability unit IVe–1; woodland suitability group 2; building site group 6.

Hayden fine sandy loam, 12 to 18 percent slopes, moderately eroded (HdD2).—This soil has lost 3 to 6 inches of its original surface soil through erosion. Plowing has mixed material from the subsoil with the remaining surface soil to form the present plow layer, a grayish-brown fine sandy loam. The subsoil is more sandy than that in the profile described for the series. In some areas there are small gullies.

Mapped with this soil are small areas of sand and gravel. In some areas slopes are very irregular, and here small areas of Glencoe and Webster soils are in the depressions between the slopes.

This soil is fair for crops and good for pasture. Productivity is limited because the soil is low in content of organic matter and lacks sufficient moisture for plants. The hazard of further erosion is severe and limits suitability of this soil for crops. Intensive practices are needed to prevent further erosion. Capability unit IVe–1; woodland suitability group 2; building site group 6.

Hayden loam, 2 to 6 percent slopes (HlB).—The profile of this soil is similar to the one described for the series. The slopes generally are gently undulating. In places, however, the slopes are irregular, and in these there are small areas of moderately well drained and poorly drained soils in depressions between the slopes.

If this Hayden soil is well managed, it is good for crops and pasture. The slopes are mild, but the soil is subject to erosion and practices are needed for control of erosion. Capability unit IIe–3; woodland suitability group 1; building site group 4.

Hayden loam, 2 to 6 percent slopes, moderately eroded (HlB2).—This soil generally has short, irregular slopes. From 3 to 6 inches of the original surface soil has been lost through erosion. The present plow layer is a mixture of dark grayish-brown material from the remaining surface soil and of brownish, finer textured material from the subsoil.

Mapped with this soil, in areas where the slopes are complex, are small poorly drained soils in depressions between the slopes.

If this Hayden soil is well managed, it is good for crops and pasture. The hazard of further erosion is moderate. Capability unit IIe–3; woodland suitability group 1; building site group 4.

Hayden loam, 6 to 12 percent slopes (HlC).—This soil generally has short, irregular slopes. Most areas are in woods or pasture or in places that have been cleared recently and put in crops.

Mapped with this soil are small areas of Webster or Glencoe soils in depressions between complex slopes.

This Hayden soil is good for crops and pasture. Because of the slopes, however, the hazard of erosion is severe if this soil is cropped. Capability unit IIIe–2; woodland suitability group 2; building site group 5.

Hayden loam, 6 to 12 percent slopes, moderately eroded (HlC2).—This soil has lost from 3 to 6 inches of its original surface soil through erosion. The present plow layer is grayish brown and consists of a mixture of loam from the remaining surface soil and of finer textured material that formerly was in the subsoil.

Mapped with this soil are small areas of Glencoe and Webster soils in depressions between irregular slopes.

Because of erosion the content of organic matter in this Hayden soil is low. As a result the soil is in poor tilth and productivity is lowered. This soil tends to crust, which slows penetration of water into the soil. Also if this soil is cultivated and not protected, the hazard of further erosion is severe.

This soil is good for crops and pasture. Good management is needed for increased yields. Capability unit IIIe–2; woodland suitability group 2; building site group 5.

Hayden loam, 12 to 18 percent slopes (HlD).—Most of this soil is in woods or pasture. It is 30 to 36 inches deep over limy underlying material. Runoff is greater than on less sloping soils. Consequently, though the capacity for storing moisture is fairly high, crops are likely to be damaged by lack of moisture during periods of low rainfall.

Mapped with this soil are small areas of Glencoe and Webster soils in depressions between irregular slopes.

This Hayden soil is fair for crops and good for pasture. The hazard of erosion is severe and limits suitability of the soil for crops. Intensive practices are needed to prevent further erosion. Capability unit IVe–1; woodland suitability group 2; building site group 6.

Hayden loam, 12 to 18 percent slopes, moderately eroded (HlD2).—This soil has lost from 3 to 6 inches of its original surface soil through erosion. Plowing has mixed dark grayish-brown material from the remaining surface soil with brownish, finer textured material from the subsoil to form the present plow layer. Depth to limy underlying material is 24 to 36 inches.

Mapped with this soil are small areas of Glencoe and Webster soils in depressions between irregular slopes.

The content of organic matter is low in this Hayden soil. As a result the soil is in poor tilth and tends to crust. Runoff is rapid, and crops are likely to be damaged from lack of moisture in dry periods.

This soil is fair to poor for crops and good for pasture. The severe hazard of erosion limits suitability for crops. Intensive practices are needed to prevent further erosion. Capability unit IVe–1; woodland suitability group 2; building site group 6.

Hayden loam, 18 to 25 percent slopes (HlE).—This soil generally is about 24 to 36 inches over limy underlying material. Areas in woods or pasture are little eroded,

but cropped areas have lost 3 to 6 inches of their original surface soil through erosion.

Mapped with this soil are several areas in which the surface soil is fine sandy loam. Also included are small areas of Glencoe and Webster soils in depressions between complex slopes.

Because of the slopes, the hazard of erosion on this Hayden soil is severe. Use of this soil for crops is therefore limited. This soil generally is not suited to tilled crops, but it is good for hay or pasture if well managed. Capability unit VIe–1; woodland suitability group 3; building site group 7.

Hayden loam, 25 to 35 percent slopes (HlF).—This soil is on hills, ridges, and sides of ravines. The areas are mostly in woods or pasture. Cropped areas have lost from 3 to 6 inches of the original surface soil through erosion. Depth to limy underlying material is 24 to 36 inches.

Mapped with this soil are a few areas in which the surface soil is fine sandy loam. Also included are small areas of Glencoe or Webster soils in depressions between complex slopes.

Runoff is very rapid on this Hayden soil, and the hazard of erosion is severe. In periods of low rainfall, pastures dry up. This soil should never be tilled. It is best to keep the areas under a permanent cover of vegetation. Careful management also is needed. Capability unit VIIe–1; woodland suitability group 3; building site group 7.

Hayden soils, 18 to 25 percent slopes, severely eroded (HnE3).—These soils have lost nearly all of their original surface soil through erosion. The present plow layer is brownish in color and is mostly clay loam that formerly was in the subsoil. Depth to limy underlying material is 24 to 36 inches. Gullies occur in places.

Mapped with this soil are small areas of Glencoe and Webster soils in depressions between complex slopes.

The content of organic matter in this Hayden soil is low, and tilth is therefore poor. Runoff is rapid, and the hazard of further erosion is severe. Establishing a seedbed and maintaining a cover of vegetation on this soil is difficult. Consequently this soil is not suitable for cultivation. It is best to keep a permanent cover of vegetation on the areas and severely restrict use. Capability unit VIIe–1; woodland suitability group 3; building site group 7.

Hubbard Series

In the Hubbard series are deep, nearly level to very steep, somewhat excessively drained to excessively drained soils. These soils occupy large areas on plains and terraces. They are underlain by glacial outwash that is acid and sandy.

The surface layer is sandy loam or loamy sand. In the sandy loams the surface layer is very dark gray and is about 10 inches thick. The subsoil is about 11 inches thick. It is very dark grayish-brown to dark-brown sandy loam that grades to dark-brown loamy sand in the lower part. The underlying material is dark-brown sand (fig. 11). In the loamy sands the surface layer is black and is about 9 inches thick. The subsoil, a dark yellowish-brown loamy sand, is about 7 inches thick. The underlying material is yellowish-brown sand that grades to dark-brown sand. In both of these depth to sand is less than 24 inches, but the loamy sands are more droughty and more susceptible to wind erosion.

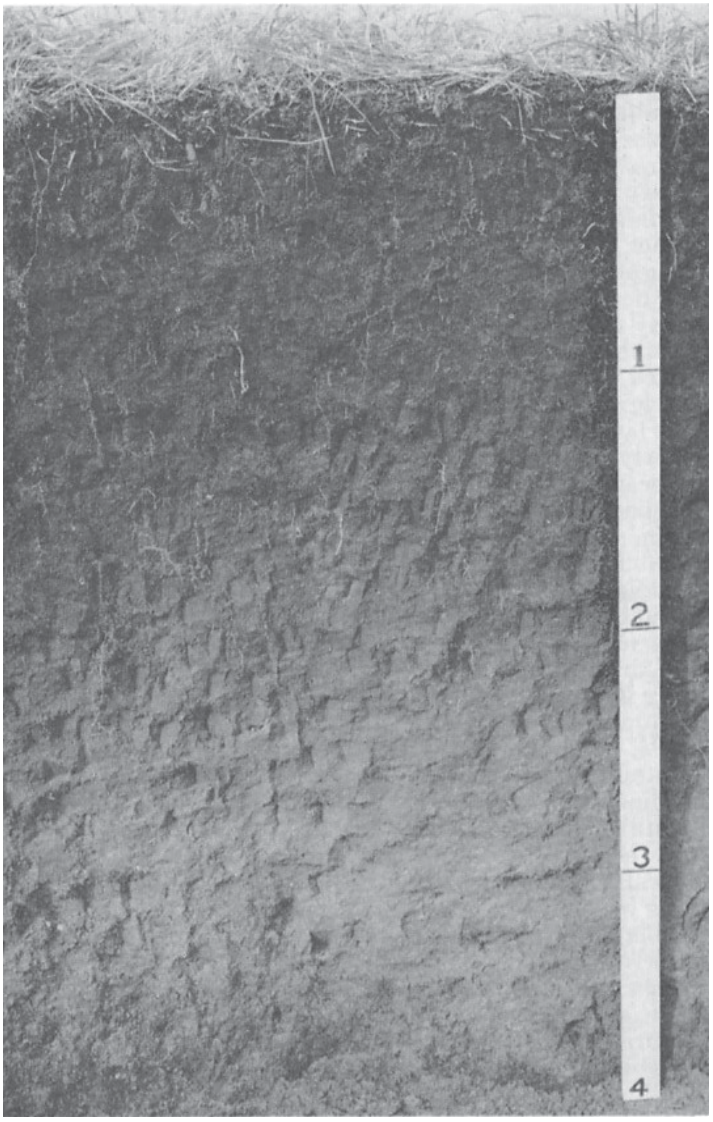

Figure 11.—**Profile of a Hubbard sandy loam; the units on the measure show depth in feet.**

Hubbard soils are medium acid to strongly acid throughout the profile. Depth to limy sand generally is more than 60 inches. Fertility is low, though crops on these soils respond well if fertilizer is applied. The moisture-supplying capacity is low to very low. Runoff is medium, and internal drainage and permeability are rapid.

Because air and water move freely through these soils, they warm up early in spring and are easy to work following a rain. They are droughty, however, and are subject to wind erosion.

Hubbard loamy sand, 0 to 2 percent slopes (HrA).—In places a thin layer of wind-drifted sand covers the original surface layer of this soil, but its profile is otherwise like the loamy sand described for the series.

Very low moisture-supplying capacity and the hazard of wind erosion severely limit use of this soil. This soil

is fairly suitable for small grains and pasture, but it generally is too droughty for corn. Capability unit IVs–1; woodland suitability group 6; building site group 1.

Hubbard loamy sand, 2 to 6 percent slopes (HrB).—In places a thin layer of wind-drifted sand covers the original surface layer of this soil.

Very low moisture-supplying capacity and the hazard of wind erosion severely limit use of this soil. This soil is poor for small grains and pasture and generally is too droughty for corn. Practices that control wind erosion are needed. Capability unit IVs–1; woodland suitability group 6; building site group 1.

Hubbard loamy sand, 2 to 6 percent slopes, moderately eroded (HrB2).—This soil has lost from 3 to 6 inches of its original surface soil through wind erosion. The present plow layer is grayish-brown loamy sand. Depth to sandy underlying material generally is 10 to 14 inches.

Because this soil is very droughty, success of crops on it depends on distribution of rainfall during the growing season. Control of wind erosion is also a serious problem. Capability unit IVs–1; woodland suitability group 6; building site group 1.

Hubbard loamy sand, 6 to 12 percent slopes (HrC).—Most of this soil is in pasture or has not been cultivated intensively. Depth to sandy underlying material generally is 10 to 14 inches.

Droughtiness severely limits use of this soil for crops. Also if this soil is cropped, erosion is difficult to control. Capability unit VIs–1; woodland suitability group 6; building site group 2.

Hubbard loamy sand, 6 to 12 percent slopes, moderately eroded (HrC2).—This soil has strong slopes that generally are fairly short. It has lost from 3 to 6 inches of its original surface soil through erosion. The present plow layer is grayish-brown loamy sand. Depth to sandy underlying material generally is 10 to 14 inches.

Very low moisture-supplying capacity causes this soil to be droughty and severely limits its use for crops or pasture. Controlling erosion is also a serious problem. Capability unit VIs–1; woodland suitability group 6; building site group 2.

Hubbard loamy sand, 12 to 35 percent slopes, moderately eroded (HrE2).—This soil is moderately steep to very steep. Most of the very steep areas are in pasture or woods and are little eroded. In areas that have been cropped, however, erosion has washed away as much as two-thirds of the original surface soil. The present plow layer is brownish loamy sand. Depth to sandy underlying material ranges from 10 to 14 inches. In a few places thin layers of finer textured material are in the sandy subsoil and substratum.

Use of this soil is severely limited because of the hazards of drought and erosion. This soil is not suited to crops, and its use for pasture is limited. It is best to keep a permanent cover of vegetation on the areas. Careful management is also needed. Capability unit VIIs–1; woodland suitability group 7; building site group 3.

Hubbard sandy loam, 0 to 2 percent slopes (HuA).—In places, and especially near old fence lines, a thin layer of wind-drifted, sandy material covers the original surface layer of this soil.

This soil is droughty and is subject to wind erosion. It is suited to small grains and pasture, but in most years it lacks sufficient moisture for good yields of corn. Capability unit IIIs–1; woodland suitability group 4; building site group 1.

Hubbard sandy loam, 0 to 2 percent slopes, moderately eroded (HuA2).—This soil has lost from 3 to 6 inches of its original surface soil through wind erosion. The present plow layer is grayish-brown sandy loam and consists of a mixture of the remaining surface soil and of material formerly in the subsoil. Depth to sandy underlying material generally is 16 to 18 inches.

Drought and wind erosion are the major problems on this soil. This soil is suited to small grains and pasture, though in dry periods, pastures dry up. It generally is too droughty for good yields of corn unless rainfall is well distributed throughout the growing season. Capability unit IIIs–1; woodland suitability group 4; building site group 1.

Hubbard sandy loam, 2 to 6 percent slopes (HuB).—This soil has a slightly thinner surface soil and subsoil, but its profile is otherwise similar to the one described for the series. In some areas slopes are hummocky or complex, and in the shallow depressions between the slopes, the soil is moderately well drained to well drained.

This soil is fair for small grains but generally lacks sufficient moisture for good yields of corn. It provides good pasture early in the grazing season but is droughty when the amount of rainfall lessens. Erosion is also a serious problem. Capability unit IIIe–4; woodland suitability group 4; building site group 1.

Hubbard sandy loam, 2 to 6 percent slopes, moderately eroded (HuB2).—This soil has lost from 3 to 6 inches of its original surface soil through erosion. The present plow layer is grayish-brown sandy loam and consists of a mixture of material from the remaining surface soil and of material formerly in the subsoil. Depth to sandy underlying material generally is 14 to 18 inches.

This soil is good for small grains and provides fair pasture if the supply of moisture is adequate. Yields of corn are severely limited because of the low moisture-supplying capacity. This soil is also droughty and is subject to further erosion. Practices that control erosion and prevent further droughtiness are needed. Capability unit IIIe–4; woodland suitability group 4; building site group 1.

Hubbard sandy loam, 6 to 12 percent slopes (HuC).—This soil is little eroded because it is mostly in pasture or has not been cultivated intensively. Depth to sandy underlying material generally is 16 to 18 inches. In places slopes are complex and the soil in small depressions between the slopes is slightly wet.

Use of this soil is severely limited because of low moisture-supplying capacity. Erosion is a serious problem if this soil is cropped. Capability unit IVe–2; woodland suitability group 4; building site group 2.

Hubbard sandy loam, 6 to 12 percent slopes, moderately eroded (HuC2).—This soil has lost from one-fourth to three-fourths of its original surface soil through erosion. The present plow layer is grayish-brown sandy loam and consists of a mixture of material from the remaining surface soil and of material formerly in the subsoil. Depth to sandy underlying material generally is 14 to 16 inches. In some places slopes are very irregular and the soil in small depressions between the slopes is slightly wet.

Low moisture-supplying capacity severely limits use of this soil. This soil is fair for small grains and pasture,

but in most years it is too droughty for corn. Erosion is also a serious problem. Capability unit IVe–2; woodland suitability group 4; building site group 2.

Hubbard Series, Gravelly Subsoil Variant

The variants from the normal Hubbard soils are shallow, nearly level to rolling, and excessively drained. These soils are on outwash plains. They consist of loamy sand over gravel and sand.

The surface layer is black loamy sand about 9 inches thick. Below is subsoil of very dark grayish brown loamy sand about 10 inches thick. The underlying material is loose, dark yellowish-brown gravel and coarse sand.

These soils are slightly acid to medium acid to a depth of 48 inches, but they generally are calcareous within a depth of 72 inches. Fertility is low to very low and moisture-supplying capacity is very low. Internal drainage and permeability are rapid. Runoff is slow, and much of the rainfall moves readily through the profile. These soils warm up early in spring and are easy to work following a rain. They are very droughty, however, and are subject to erosion.

Hubbard loamy sand, gravelly subsoil variant, 0 to 2 percent slopes (HsA).—This soil is in areas that have a few slight rises and a few depressional areas that are well drained. In some places a thin mantle of wind-drifted sand covers the original surface soil. Depth to sand and gravel ranges from 10 to 20 inches.

This soil is fair to poor for small grains and pasture. It is too droughty for corn. Very low moisture-supplying capacity and susceptibility to wind erosion severely limit its use. Capability unit IVs–2; woodland suitability group 8; building site group 1.

Hubbard loamy sand, gravelly subsoil variant, 2 to 6 percent slopes (HsB).—This soil has short, smooth slopes. In some places a thin mantle of wind-drifted sand covers the original surface soil. In a few places a small amount of gravel is on the surface. Depth to sand and gravel ranges from 10 to 16 inches.

This soil is very droughty. It is fair to poor for small grains and pasture and lacks sufficient moisture for corn. Careful management is needed for control of wind erosion. Capability unit IVs–2; woodland suitability group 8; building site group 1.

Hubbard loamy sand, gravelly subsoil variant, 2 to 6 percent slopes, moderately eroded (HsB2).—This soil has short, smooth slopes. From 3 to 6 inches of the original surface soil has been removed through erosion. The present plow layer is brownish loamy sand. Depth to loose sand and gravel ranges from 6 to 12 inches. In places a small amount of gravel is on the surface.

This soil is very droughty and blows easily. It is poor for small grains and pasture and lacks sufficient moisture for corn. Careful management is needed for control of wind erosion. Capability unit IVs–2; woodland suitability group 8; building site group 1.

Hubbard loamy sand, gravelly subsoil variant, 6 to 12 percent slopes (HsC).—This soil has strong slopes that generally are fairly short. Depth to sand and gravel ranges from 10 to 16 inches. In a few places a small amount of gravel is on the surface.

Use of this soil is severely limited because of the hazards of drought and erosion. This soil is not suited to crops, and its use for pasture is limited. It is best to keep a permanent cover of vegetation on the areas. Careful management also is needed. Capability unit VIIs–2; woodland suitability group 8; building site group 2.

Lake Borders

Lake borders (0 to 5 percent slopes) (Lb) consists of wet, silty soil material around present lakes and the borders of former lakes. The soil material lacks distinct layers. In some places a thin layer of peat or muck overlies the surface. Most areas are nearly level, but because of gradual lowering of the level of the lakes during the time the material was deposited, some slopes are as much as 5 percent. Areas near present lakes are sometimes submerged during periods when the water level is high. The native vegetation was slough grass, sedges, reeds, and willows. The material in this land type is finer textured than that of Beach materials, sandy.

Lake borders has high fertility and moisture-supplying capacity. The soil material ranges from mildly alkaline to medium alkaline. Areas that are protected from overflow and adequately drained produce good yields of corn and soybeans. Undrained areas are poor for pasture. Capability unit IIIw–1; woodland suitability group 11; building site group 10.

Lester Series

The Lester series consists of deep, well-drained soils formed in limy loam or clay loam glacial till. These soils occupy large, undulating to hilly areas in the upland. Slopes generally are uneven or complex.

The surface layer is black or very dark gray loam that is somewhat lighter gray in the lower part. It is about 9 inches thick. The subsoil, a grayish-brown clay loam, is about 30 inches thick. Below is yellowish-brown clay loam. A profile of a Lester loam is shown in figure 12.

Lester soils are neutral to slightly acid in the surface soil. The subsoil is slightly acid to strongly acid. Limy underlying material generally is at a depth of more than 30 inches. Fertility and moisture-supplying capacity are high. Runoff is medium to rapid, depending on the steepness of the slope. Internal drainage is medium, and permeability is moderate. Air and water move readily through these soils if they are in good tilth.

In some places the Lester soils are intermingled with areas of Estherville or Storden soils. In those areas it was impractical to map the soils separately, and they are therefore mapped as complexes. A description of the Estherville and Storden soils is given under their respective series.

Lester clay loam, 6 to 12 percent slopes, severely eroded (LcC3).—This soil has lost nearly all of its original surface soil and in places part of its subsoil through erosion. The present plow layer is yellowish-brown clay loam and consists mostly of material formerly in the subsoil. Depth to limy underlying material is 24 to 30 inches. Limy spots of clay loam occur in places on the more abrupt slopes. A few areas are cut by small gullies.

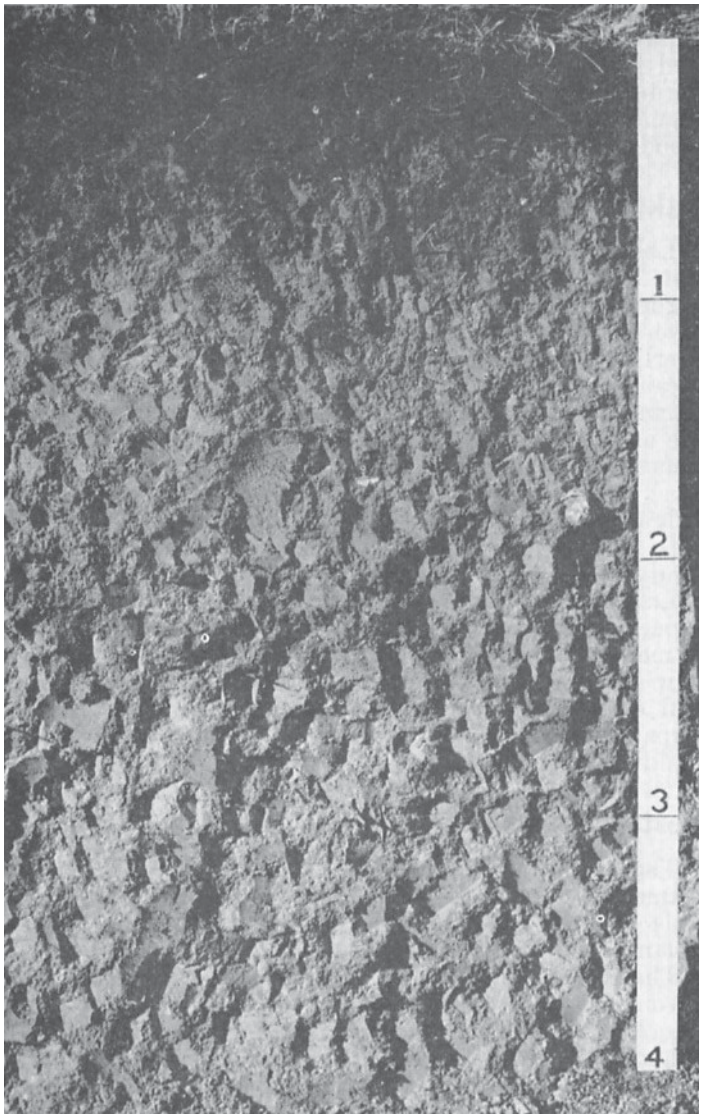

Figure 12.—**Profile of a Lester loam; the units on the measure show depth in feet.**

Low content of organic matter, poor tilth, and the severe hazard of erosion limit productivity of this soil. Also it is difficult to cultivate and to prepare a seedbed in this soil. Loss of organic matter has decreased the infiltration of water into the soil and lowered the moisture-supplying capacity. Consequently in some years this soil is slightly droughty.

This soil is poor for crops and good for pasture. It is not suitable for continuous cultivation. Capability unit IVe–1; woodland suitability group 2; building site group 5.

Lester clay loam, 12 to 18 percent slopes, severely eroded (LcD3).—This soil has lost nearly all of its original surface soil through erosion. Some areas are gullied. The present plow layer is yellowish-brown clay loam and consists mostly of material formerly in the subsoil. Depth to limy underlying material is 20 to 30 inches. Limy spots of clay occur in places on the more abrupt slopes.

Mapped with this soil are small areas of Glencoe and Webster soils in depressions between complex slopes.

Low organic matter, poor tilth, and the severe hazard of erosion limit productivity of this Lester soil. Also it is difficult to cultivate and prepare a seedbed in this soil. Loss of organic matter has decreased the infiltration of water into the soil and lowered the moisture-supplying capacity. Consequently in some years this soil is slightly droughty.

This soil is not suitable for cultivation. It is best to keep the areas under a permanent cover of vegetation. Capability unit VIe–1; woodland suitability group 2; building site group 6.

Lester clay loam, 18 to 25 percent slopes, severely eroded (LcE3).—Most of this soil is cultivated, and as a result nearly all of the original surface soil has been removed through erosion. Some areas are gullied. The present plow layer is yellowish-brown clay loam and is mostly material formerly in the subsoil. It has a low content of organic matter and is in poor tilth. Depth to limy underlying material generally is less than 30 inches. In places spots of limy clay loam are on the surface. Runoff is rapid, and it is difficult to establish a seedbed and to keep a cover of vegetation on this soil.

Mapped with this soil are small areas of Glencoe and Webster soils in depressions between complex slopes.

Because of strong slopes and the hazard of further erosion, this Lester soil is not suitable for cultivation. It is best to keep a permanent cover of vegetation on this soil. Capability unit VIIe–1; woodland suitability group 3; building site group 7.

Lester loam, 2 to 6 percent slopes (LeB).—This soil has a profile similar to the one described for the series. Slopes generally are undulating, but in some places they are very irregular.

Included with this soil are small areas of moderately well drained and poorly drained soils in small depressions between irregular slopes.

This soil is well suited to all crops generally grown in the county. Slopes are mild. Nevertheless this soil is subject to erosion, and care is needed for control of erosion. Capability unit IIe–2; woodland suitability group 1; building site group 4.

Lester loam, 2 to 6 percent slopes, moderately eroded (LeB2).—This soil generally has short, irregular slopes. It has lost 3 to 6 inches of its original surface soil through erosion. The present plow layer is a mixture of dark-colored material from the remaining surface soil and of brownish, finer textured material formerly in the subsoil.

Mapped with this soil are small areas of a poorly drained soil in depressions between uneven slopes.

This Lester soil is good for crops and pasture. The hazard of further erosion is moderate. Capability unit IIe–2; woodland suitability group 1; building site group 4.

Lester loam, 6 to 12 percent slopes (LeC).—This soil generally has short, irregular slopes. Most areas are in pasture or woods or have been cleared recently and put in crops.

Mapped with this soil are small areas of Webster and Glencoe soils in depressions between complex slopes.

This Lester soil is good for crops and pasture. It is strongly sloping, and the erosion hazard is severe. If this soil is well managed, it is highly productive. Practices that prevent further erosion are needed. Capability unit IIIe–1; woodland suitability group 2; building site group 5.

Lester loam, 6 to 12 percent slopes, moderately eroded (LeC2).—This soil generally has short, irregular slopes. From 3 to 6 inches of the original surface soil has been removed through erosion. The present plow layer is grayish brown and is a mixture of material from the remaining surface soil and of finer textured material formerly in the subsoil. It is in poor tilth and its productivity is lowered as the result of loss of organic matter through erosion. In places there are small, wet depressional areas.

This soil is good for crops and pasture. If it is cultivated and not protected, the hazard of further erosion is severe. Capability unit IIIe–1; woodland suitability group 2; building site group 5.

Lester loam, 12 to 18 percent slopes (LeD).—Areas of this soil in pasture or woods are little eroded. Most areas in crops, however, have lost from 3 to 6 inches of the original surface soil through erosion. In these areas plowing has mixed the remaining surface soil with finer textured material formerly in the subsoil to form the present, lighter colored plow layer. The content of organic matter in this layer is low, and it therefore generally is in poor tilth.

Mapped with this soil are small areas of Glencoe and Webster soils in depressions between irregular slopes. Also included are small areas of soil on the edges of some ridges that have a limy surface soil.

This Lester soil is fair for crops and good for pasture. Its use is limited because of the severe hazard of erosion. Practices are needed for control of erosion. Capability unit IVe–1; woodland suitability group 2; building site group 6.

Lester loam, 18 to 25 percent slopes (LeE).—The surface soil and subsoil in this soil are not so thick as in the profile described for the series. Also, depth to limy underlying material is less than 36 inches in many places. Areas in pasture or woods are little eroded, but areas in crops have lost 3 to 6 inches of the original surface soil through erosion.

Mapped with this soil are small areas of Glencoe and Webster soils between complex slopes.

Use of this Lester soil is severely limited because of the steep slopes and severe hazard of erosion. This soil is not suited to tilled crops. It is moderately productive of hay and pasture if it is well managed. Capability unit VIe–1; woodland suitability group 3; building site group 7.

Lester loam, 25 to 35 percent slopes (LeF).—This soil is on hills and ridges and the sides of ravines. It is used mostly for pasture and woods. In cropped areas as much as 3 to 6 inches of the original surface soil has been lost through erosion.

Mapped with this soil are small areas of Glencoe and Webster soils in depressions between complex slopes.

This Lester soil is subject to severe erosion and should never be tilled. Water runs rapidly off this soil, and in dry periods pasture dries up. It is best to keep a permanent cover of vegetation on this soil. Careful management is also needed. Capability unit VIIe–1; woodland suitability group 3; building site group 7.

Lester-Estherville complex, 2 to 6 percent slopes (LtB).—These soils have short, irregular slopes. Lester loam makes up about 65 percent of the acreage, and Estherville sandy loam about 20 percent. The remaining 15 percent is Estherville loam. In a few places there are small, wet depressional areas.

Soils in this mapping unit are subject to moderate erosion. The Estherville soils also are somewhat droughty. These soils therefore are fair to good for crops and pasture. Capability unit IIe–4; woodland suitability group 1; building site group 4.

Lester-Estherville complex, 2 to 6 percent slopes, moderately eroded (LtB2).—These soils have short, irregular slopes. Lester loam makes up about 65 percent of the acreage, and Estherville sandy loam about 20 percent. The remaining 15 percent is Estherville loam. Erosion has removed from one-fourth to three-fourths of the original surface layer of these soils. In places a few small spots of gravel are on the surface, and in other places there are small, wet depressions.

Soils in this mapping unit are subject to further erosion. The Estherville soils also are somewhat droughty. These soils therefore are fair for crops and pasture. Capability unit IIe–4; woodland suitability group 1; building site group 4.

Lester-Estherville complex, 6 to 12 percent slopes (LtC).—These soils have short, irregular slopes. Estherville sandy loam makes up about 40 percent of the acreage, and Estherville loam about 15 percent. The remaining 45 percent is Lester loam. From one-fourth to three-fourths of the original surface soil has been washed away through erosion. Plowing has mixed material from the subsoil with the remaining surface soil to form the present grayish-brown plow layer. In many places small spots of gravel are on the surface or there are barren yellowish spots of limy clay loam. A few areas are in woods or pasture and are little eroded.

These soils generally are droughty, and the hazard of erosion is severe. They are fair for crops and good for pasture. Capability unit IVe–3; woodland suitability group 4; building site group 5.

Lester-Estherville complex, 12 to 18 percent slopes (LtD).—Soils of this complex are on irregular ridges and sharp breaks. Estherville sandy loam makes up about 65 percent of the acreage, and the remaining 35 percent is Lester loam. As much as three-fourths of the original surface soil has been removed through erosion. In some places small spots of gravel are on the surface or there are barren yellowish spots of limy clay loam.

These soils are droughty, and the hazard of erosion is severe. They are not suitable for cultivation. It is best to keep the areas under a permanent cover of vegetation. Capability unit VIe–2; woodland suitability group 5; building site group 6.

Lester Series, Silty Variant

The variants from the normal Lester series are deep, nearly level to sloping, well drained, and silty. These soils are near the southern part of Clearwater Lake. They formed in limy silt laid down by water.

The surface layer is very dark gray silt loam about 10 inches thick. The subsoil, a silty clay loam about 14 inches thick, is dark grayish-brown to grayish brown. Below is light yellowish-brown silt loam. In undisturbed wooded and pastured areas the surface soil is very dark gray silt loam less than 4 inches thick, and the subsurface soil is a lighter gray silt loam that is about 6 inches thick.

These soils are neutral to slightly acid in the surface soil, and slightly acid to medium acid in the subsoil. The

underlying material generally is limy within a depth of 30 inches. Fertility and available moisture supplying capacity are moderately high to high. Runoff and internal drainage are medium. Permeability is moderate. These soils erode readily.

Lester silt loam, silty variant, 0 to 2 percent slopes (LrA).—This soil has a few slight rises in some places and a few depressional areas in others. In wooded areas a thin, dark-colored surface soil overlies a lighter gray subsurface soil.

This soil has few limitations to use. Yields of corn and grain are good. Capability unit I–1; woodland suitability group 1; building site group 4.

Lester silt loam, silty variant, 2 to 6 percent slopes (LrB).—This soil has fairly long, smooth slopes. In wooded areas a thin, dark-colored surface soil overlies a lighter gray subsurface soil. This soil erodes readily.

If this soil is well managed, yields of corn and small grains are good. Capability unit IIe–2; woodland suitability group 1; building site group 4.

Lester silt loam, silty variant, 2 to 6 percent slopes, moderately eroded (LrB2).—This soil has fairly long, smooth slopes. About 3 inches of the original surface soil has been removed through erosion. Plowing has mixed brownish subsoil material with the darker colored surface soil to form the present plow layer.

This soil is good for crops and pasture, but it is subject to further erosion. Capability unit IIe–2; woodland suitability group 1; building site group 4.

Lester silt loam, silty variant, 6 to 12 percent slopes, moderately eroded (LrC2).—This soil has lost 3 to 6 inches of its original surface soil through erosion. The present plow layer includes much brownish material formerly in the subsoil. In a few places the surface soil is yellowish and limy.

This soil is suitable for crops and pasture. The hazard of further erosion is severe, and special practices are needed for control of erosion if this soil is cropped. Capability unit IIIe–1; woodland suitability group 2; building site group 5.

Le Sueur Series

The Le Sueur series consists of deep, nearly level to gently sloping, moderately well drained soils. These soils are underlain by limy clay loam or loam. They occupy large areas in the upland.

The surface layer is black clay loam about 9 inches thick. Below is about 2 inches of very dark gray to gray clay loam. The subsoil, a finer textured clay loam about 23 inches thick, is dark grayish brown finely mottled with light olive brown. The underlying material is grayish-brown and light olive-brown clay loam. A profile of a Le Sueur clay loam is shown in figure 13.

These soils have a slightly acid surface soil and a slightly acid to strongly acid subsoil. Limy underlying material is at a depth of 30 to 40 inches. The fertility, content of organic matter, and moisture-supplying capacity are high. Runoff and internal drainage are medium. Permeability is moderate.

Movement of air and water through these soils is slightly restricted, but artificial drainage generally is not needed. These soils are among the most productive in the county if they are well managed.

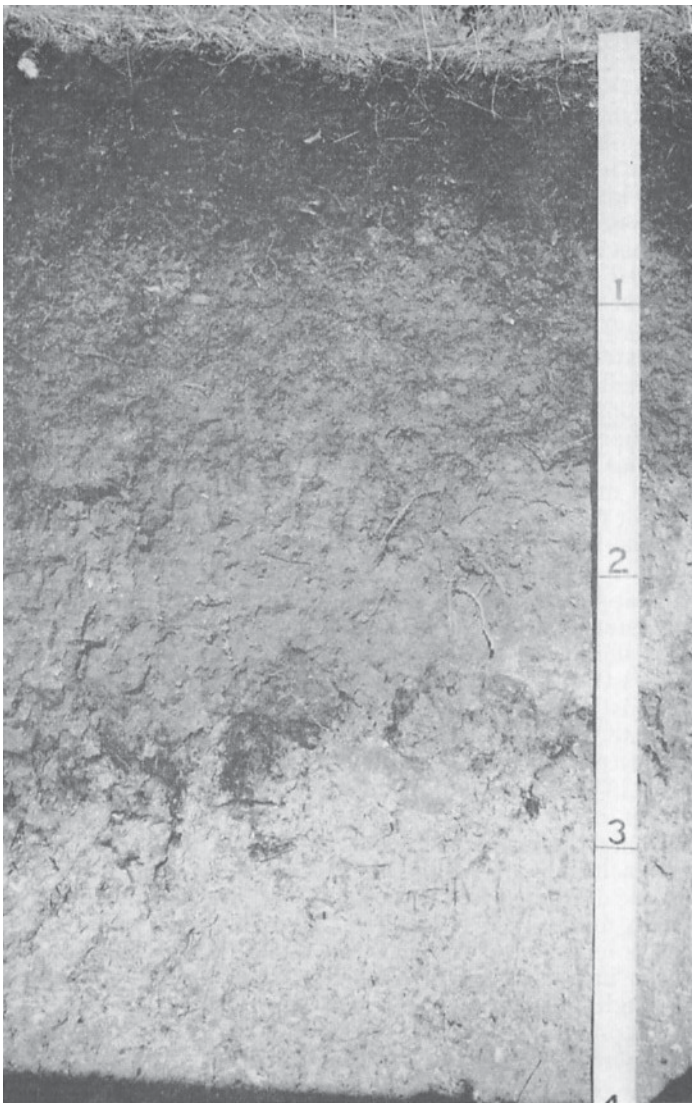

Figure 13.—**Profile of a Le Sueur clay loam; the units on the measure show depth in feet.**

Le Sueur clay loam, 0 to 2 percent slopes (LuA).—The profile of this soil is similar to the one described for the series. In some places there are small areas in which the soil is poorly drained.

This soil is productive and has few limitations to use. Row crops can be grown on it intensively under good management. It also is good for pasture, but its value for crops is greater. Capability unit I–1; woodland suitability group 1; building site group 8.

Le Sueur clay loam, 2 to 6 percent slopes (LuB).—The profile of this soil is similar to the one described for the series. In places the areas are hummocky and small wet depressions are between the slopes.

This soil is good for crops or pasture. Even though the slopes are gentle, this soil is subject to erosion if it is not protected. Capability unit IIe–1; woodland suitability group 1; building site group 8.

Marna Series

The Marna series consists of deep, poorly drained soils. These soils are on nearly level flats and in slightly depressed drainageways in the upland, mostly in the southwestern part of the county. They formed in clay deposited over limy clay loam glacial till.

The surface layer is black silty clay loam about 10 inches thick. Below is dark-gray silty clay mottled with olive gray and gray that is about 20 inches thick. The underlying material is olive-gray silty clay loam or clay loam.

Marna soils are neutral to medium acid in the surface soil and subsoil. Limy clay loam or silty clay loam material is at a depth of 24 to 48 inches. The fertility, content of organic matter, and moisture-supplying capacity are high. Runoff and internal drainage are slow, and permeability is moderately slow. The water table is seasonally fairly high.

Because water moves somewhat slowly through these soils, the effectiveness of tile drainage is lessened. If these soils are drained and otherwise well managed, yields of corn and soybeans are good.

Marna silty clay loam (0 to 2 percent slopes) (Ma).—This is the only Marna soil mapped in the county. Its profile is similar to the one described for the series. This soil is on nearly level flats and in slightly depressed areas. In small areas the surface soil is silty clay.

Excess water somewhat limits use of this soil. If drained and otherwise well managed, this soil is good for crops or pasture. Practices that maintain tilth and the effectiveness of the drainage system are needed. Capability unit IIw–1; woodland suitability group 10; building site group 9.

Marsh

Marsh (0 to 1 percent slopes) (Mh) is in shallow lakes and ponds that are dry in places during years when precipitation is less than normal. A few areas have been drained. Most areas, however, are wet the year round. The vegetation consists of cattails, rushes, sedges, and other plants that tolerate wetness. The soil material is too wet to be classified.

Marsh is excellent for wildlife. The areas are poor for pasture, but wild hay can be cut in places along the edges of some marshy areas. If areas of Marsh were artificially drained, they could be used for crops and would be managed much the same as the Peat and mucks or as the Glencoe soils. Capability unit VIIIw–1; woodland suitability group 11; building site group 10.

Milaca Series

In the Milaca series are deep, well-drained soils. These soils are underlain by reddish-brown, acid silty clay loam till. They are on undulating to very steep and irregular slopes in the upland, mostly in Silver Creek Township in the north-central part of the county.

In cultivated areas the plow layer is dark grayish-brown loam about 8 inches thick. Below is about 30 inches of dark-brown to reddish-brown sandy clay loam. The underlying material is reddish-brown silty clay loam. In undisturbed woods and pasture, the surface soil is very dark gray loam that is less than 3 inches thick and is underlain by about 5 inches of lighter gray loam.

Milaca soils are slightly acid to medium acid throughout the profile and underlying material. Fertility and moisture-supplying capacity are moderate. The content of organic matter is low. Runoff is medium to rapid, depending on the steepness of the slope. Internal drainage is medium, and permeability is moderate or moderately rapid.

These soils are used for dairy farming. On the less rolling areas, good yields of corn and oats are produced.

Milaca loam, 2 to 6 percent slopes, moderately eroded (MlB2).—This soil has fairly smooth, undulating slopes. Its profile is similar to the one described for the series. In a few small areas the surface soil is sandy loam.

This soil is good for crops and pasture. The slopes are mild, but cultivated areas have lost as much as one-half of the original surface soil through erosion. Capability unit IIe–3; woodland suitability group 1; building site group 4.

Muck, Deep

Muck, deep (0 to 2 percent slopes) (Mu) consists of very poorly drained, organic material made up of well-decomposed vegetation. It is in low wet areas along the edges of present lakes and ponds and bottom lands of streams, and also is in old lake bottoms.

The soil material is black to very dark brown in color. It is well decomposed.

Muck, deep, ranges from 12 inches to more than 12 feet in depth, but in most places it is about 3 to 6 feet deep. The underlying material generally is olive gray and silty, but in places it is sand. The soil material is slightly acid to slightly alkaline. Fertility is moderate, and the water-supplying capacity is high.

Undrained areas are seasonally ponded, and have marsh grasses, reeds, and sedges growing on them. Artificial drainage is necessary before the areas can be cropped. Wetness severely limits use.

Undrained areas of Muck, deep, are poor for pasture but provide some wild hay. If adequately drained and properly fertilized, Muck, deep, produces good yields of row crops and truck crops in favorable years. In some years, however, crops are seriously damaged by summer frost. Capability unit IIIw–3; woodland suitability group 11; building site group 10.

Nessel Series

Soils of the Nessel series are deep, nearly level to gently sloping, and moderately well drained. These soils are in the upland, mostly in the northeastern part of the county. They are underlain by limy clay loam or loam glacial till.

In undisturbed woods or pasture, the surface soil is very dark brown silt loam about 3 inches thick. Between the surface soil and the subsoil is a layer of lighter gray loam about 4 inches thick. The subsoil is dark grayish-brown and light olive-brown heavy clay loam about 28 inches thick. It is underlain by grayish-brown and light olive-brown clay loam. In cultivated fields the plow layer is dark grayish-brown silt loam.

Nessel soils have a slightly acid surface soil and a slightly acid to strongly acid subsoil. Limy underlying material is at a depth of 30 to 40 inches. Fertility is moderate, and the content of organic matter is low. The moisture-supplying capacity is moderately high. Runoff and internal drainage are medium. Permeability is moderate.

Movement of water through this soil is slightly restricted, but this does not adversely affect yields. Yields of all crops generally grown are good if good management is used. Artificial drainage generally is not needed.

Nessel silt loam, 0 to 2 percent slopes (NeA).—The profile of this soil is similar to the one described for the series. In cultivated areas the plow layer is dark grayish brown. In a few areas the surface soil is loam. Small, shallow, wet depressions occupy a few areas.

This soil has few limitations to use. It is very good for crops and pasture. If the content of organic matter is replenished and other good management is used, this soil can be cropped intensively. Capability unit IIe–3; woodland suitability group 1; building site group 8.

Nessel silt loam, 2 to 6 percent slopes (NeB).—The profile of this soil is similar to the one described for the series. In cultivated areas the plow layer is dark grayish brown. In a few areas the surface soil is loam. Small, wet depressions occupy a few areas.

Slopes are mild, but this soil is nevertheless subject to erosion. It is good for crops and pasture, and yields are good under good management. Capability unit IIe–3; woodland suitability group 1; building site group 8.

Peat and Muck

Peat consists of the organic remains of marsh grasses, sedges, and reeds in low, wet areas. It is mostly dark-brown, fibrous, and spongy. Muck consists of well-decomposed, finely divided peat that has a higher mineral content than peat and also is more silty. The areas are in the many depressions and large bogs in old lake bottoms that occur throughout the county.

In this county there are three mapping units of Peat and muck. The separation is based on the depth of the organic material and the texture of the underlying material. Depth ranges from 1 foot to more than 20 feet, and generally the bogs in rolling to hilly areas contain the deepest deposits. Most of the Peat and muck is slightly acid to slightly alkaline. Individual areas should be tested for acidity, however, before placing cement tile or before planting crops. All areas are too wet for crops unless they are artificially drained. Fertility is low, but crops on Peat and muck respond well if fertilizer that contains potash and phosphate is applied in large amounts. In some years crops are damaged severely by summer frost.

Peat and muck, deep (0 to 1 percent slopes) (Pa).—This mapping unit is in wet, depressional areas throughout the county, but the largest areas are bogs in old lake bottoms. It consists of deposits of peat or muck that generally are 3½ to about 7 feet thick, but that are more than 20 feet thick in places. These deposits are underlain by material that ranges from silty clay to sand and gravel in texture.

Most areas of this mapping unit are wet and marshy part of the year, but they ordinarily dry out by midsummer. The areas are poor for pasture and hay, and drainage is needed if crops are grown. Large amounts of fertilizer that contains phosphate and potash are also needed. If this soil is adequately drained and properly fertilized, yields of corn and truck crops are good in favorable years. In some years crops are damaged severely by summer frost. Capability unit IIIw–3; woodland suitability group 11; building site group 10.

Peat and muck, shallow over loam (0 to 1 percent slopes) (Pm).—This mapping unit is in depressions and drainageways throughout the upland. It consists of deposits of peat or muck that are 1 to 3½ feet thick. These deposits are underlain by olive-gray loam to clay loam. Most of the peat is quite raw, but in areas that have been drained and cultivated the peat is more decomposed. In some areas a thin layer of mineral soil washed from nearby slopes covers the areas.

Artificial drainage is needed before this mapping unit is used for crops. If the soil is adequately drained and fertilized, yields of corn and truck crops are good in favorable years. In some years, however, crops are likely to be damaged by summer frost. Undrained areas are fair for pasture and hay. Capability unit IIIw–3; woodland suitability group 11; building site group 10.

Peat and muck, shallow over sand (0 to 1 percent slopes) (Ps).—This mapping unit is mostly in depressions in sandy outwash plains and stream terraces, but a few areas are along the edges of lakes that have a bottom of sand. It consists of deposits of peat or muck that are 1 to 3½ feet thick over sand.

Most of this mapping unit is used for wild hay or pasture, especially during periods of drought. It is too wet for crops, and drainage other than shallow surface ditches generally is not feasible. Maintaining a drainage system is a problem because the underlying sand is loose and tends to flow when wet. The layer of peat or muck decreases rapidly in thickness if farmed intensively. If the layer is shallow when first cultivated, after a few years of cultivation only the underlying sand remains. Fertility is very low, and large amounts of phosphate and potash are needed if crops are grown. The hazard of frost is a continuing problem. Capability unit Vw–1; woodland suitability group 11; building site group 10.

Rasset Series

In the Rasset series are deep, nearly level to rolling, well drained and moderately well drained, sandy soils. These soils are on outwash plains of the North Fork of the Crow River.

In cultivated fields the plow layer is black loamy sand about 9 inches thick. Below is about 10 inches of very dark grayish-brown sandy loam. The underlying material to a depth of more than 42 inches is dark-brown and dark yellowish-brown sand. It contains thin layers of loamy sand and very thin layers of sandy clay loam in a few places. In places the surface layer is sandy loam. These sandy loams have a thicker surface layer than the loamy sands and are somewhat less droughty.

Rasset soils are neutral to medium acid in the surface layer and underlying material. Limy material is at a depth of 48 to 72 inches. Fertility and moisture-

supplying capacity are moderately low. Runoff is slow to medium, depending on the slope. Internal drainage is medium to rapid, and permeability is moderately rapid. In places in the more level areas, the water table is seasonally fairly high, which helps to replenish moisture. Rasset soils warm up early in spring and are easy to work, but they are droughty and are subject to wind erosion.

In this county Rasset soils are mapped only in undifferentiated units with Hubbard soils. A description of the Hubbard soils is given under the Hubbard series.

Rasset and Hubbard soils, 0 to 2 percent slopes (RhA).—Soils in this mapping unit are mostly nearly level, but a few areas are on slight rises or are in depressions. The surface soil ranges from loamy sand to sandy loam. These soils have a seasonally high water table in some places, and here the subsoil is a dull grayish-brown.

These soils are droughty and are subject to wind erosion. They are fair to good for small grains and pasture. They are fair for corn, but in most years they lack sufficient moisture for good yields. Capability unit IIIs–1; woodland suitability group 4; building site group 1.

Rasset and Hubbard soils, 2 to 6 percent slopes (RhB).—These soils have short, smooth slopes. The surface soil ranges from loamy sand to sandy loam. In places there are shallow depressions and swales in which the soils are moderately well drained. In these areas the surface soil is thick and black, and the subsoil is dark grayish brown.

These soils are droughty and are subject to erosion. They are suited to small grains and pasture. They are fair for corn, but yields of this crop are limited because of lack of moisture. Capability unit IIIe–4; woodland suitability group 4; building site group 1.

Rasset and Hubbard soils, 2 to 6 percent slopes, moderately eroded (RhB2).—These soils have short, smooth slopes. From 3 to 6 inches of the original surface soil has been lost through erosion. The present plow layer is grayish brown and consists of the remaining surface soil and of material formerly in the subsoil. It ranges from loamy sand to sandy loam. In places moderately well drained Rasset soils are in the swales between complex slopes.

These Rasset and Hubbard soils are droughty and are subject to erosion. They are good to fair for small grains and provide good pasture if rainfall is adequate. Yields of corn are limited because of the low moisture-supplying capacity. Good management is needed to prevent further erosion. Capability unit IIIe–4; woodland suitability group 4; building site group 1.

Rasset and Hubbard soils, 6 to 12 percent slopes (RhC).—Most areas of these soils are in pasture or woods or have not been cultivated intensively. The surface soil ranges from loamy sand to sandy loam.

Low moisture-supplying capacity severely limits use of these soils. If these soils are cultivated, the hazard of erosion is severe and droughtiness is a serious problem. Capability unit IVe–2; woodland suitability group 4; building site group 2.

Rasset and Hubbard soils, 6 to 12 percent slopes, moderately eroded (RhC2).—These soils have lost from 3 to 6 inches of the original surface soil through erosion. The present plow layer, a grayish-brown loamy sand or sandy loam, is a mixture of the remaining surface soil and of material formerly in the subsoil.

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Low moisture-supplying capacity severely limits use of these soils. They are fair to poor for small grains and pasture and in most years are too droughty for corn. Good management is needed to prevent further erosion. Capability unit IVe–2; woodland suitability group 4; building site group 2.

Salida Series

In the Salida series are gently undulating to very steep, excessively drained, sandy soils that are very shallow to gravel and sand. These soils are on hilly slopes in areas of stream and glacial outwash.

In cultivated fields the plow layer is very dark gray gravelly sandy loam about 6 inches thick. The subsoil, a very dark grayish brown gravelly sandy loam, is about 5 inches thick. Below is loose, yellowish-brown gravel and sand.

Salida soils have a surface soil that is neutral to slightly acid. The material below generally is calcareous. Fertility and moisture-supplying capacity are very low. Because these soils are porous, runoff is slow to very slow and most precipitation moves into and through the soil readily. Internal drainage and permeability are very rapid. These soils warm up early in spring and dry out quickly following a rain. Shallowness to gravel and sand severely limits the root zone for most plants and makes the soils droughty.

Salida gravelly sandy loam, 2 to 6 percent slopes (SaB).—This soil has short undulating slopes. Its profile is like the one described for the series, but depth to loose gravel and sand is less than 12 inches.

This soil is droughty and is subject to severe erosion. It is fair to poor for small grains and pasture, depending upon the amount of rainfall during the growing season. It is not suitable for corn. Capability unit IVs–2; woodland suitability group 8; building site group 1.

Salida gravelly sandy loam, 6 to 12 percent slopes (SaC).—Most areas of this soil are on narrow ridges or are on short slopes between more level areas. In places slopes are complex. This soil consists of 6 to 10 inches of gravelly sandy loam over loose gravel and sand. Areas in pasture or woods are little eroded, but areas in crops have lost as much as three-fourths of the original surface soil.

Because of droughtiness, this soil is not suited to crops. Pasture dries up during periods of low rainfall. It is best to keep the areas under a permanent cover of vegetation. Capability unit VIIs–2; woodland suitability group 8; building site group 2.

Salida gravelly sandy loam, 12 to 35 percent slopes (SaE).—Areas of this soil in pasture or woods are little eroded, but areas in crops have lost as much as three-fourths of the original surface soil. Depth to loose gravel and sand ranges from 6 to 10 inches.

This soil is droughty and is not suited to crops. It is best to keep the areas under a permanent cover of vegetation. Capability unit VIIs–2; woodland suitability group 9; building site group 3.

Salida complex, 2 to 6 percent slopes (ScB).—Soils in this mapping unit have short, irregular slopes. The areas are in the northwestern part of the county, where the native vegetation was a mixture of oak, aspen, and prairie grasses. Most areas are in woods or pasture.

In wooded or undisturbed areas, the surface soil is black or grayish-brown gravelly sandy loam or gravelly loamy sand from less than 3 to as much as 6 inches thick. The subsoil, a very dark grayish-brown to dark grayish-brown loamy coarse sand or gravelly sandy loam, ranges from 4 to less than 10 inches in thickness. Below are deep deposits of yellowish-brown sand and gravel. Depth to loose sand and gravel generally is less than 12 inches. In cultivated fields the plow layer is dark grayish-brown gravelly sandy loam about 7 inches thick. The underlying material is loose, yellowish-brown sand and gravel.

The surface soil and subsoil range from neutral to medium acid. The underlying sand and gravel are calcareous. Fertility and moisture-supplying capacity are very slow. The underlying material ranges from stratified sand and gravel to material consisting mostly of large stones and boulders.

This soil is droughty and is not suitable for corn. It is fair to poor for small grains and pasture, depending on the amount of rainfall during the growing season. Capability unit IVs–2; woodland suitability group 8; building site group 1.

Salida complex, 6 to 12 percent slopes (ScC).—Soils in this complex have short, irregular slopes. Areas in pasture or woods are little eroded, but areas in crops have lost from one-fourth to three-fourths of the original surface soil through erosion. The present plow layer is grayish-brown gravelly sandy loam and has many spots of gravel on the surface. Depth to sand and gravel is less than 10 inches. The underlying material ranges from stratified sand and gravel to material consisting mostly of large stones and boulders.

This soil is droughty. It is not suitable for cultivated crops and is poor for pasture. It is best to keep the areas under a permanent cover of vegetation. Capability unit VIIs–2; woodland suitability group 8; building site group 2.

Salida complex, 12 to 35 percent slopes (ScE).—Areas of this mapping unit in woods or pasture have a surface soil of grayish-brown gravelly loamy sand about 7 inches thick over loose sand and gravel. Cropped areas have lost as much as three-fourths of the original surface soil through erosion. The present plow layer is yellowish-brown gravelly loamy sand that has many spots of gravel on the surface. The underlying material ranges from stratified sand and gravel to material consisting mostly of large stones and boulders.

This soil is droughty. It is not suitable for crops and is poor for pasture. It is best to keep the areas under a permanent cover of vegetation. Capability unit VIIs–2; woodland suitability group 9; building site group 3.

Sattre Series, Silty Variant

These variants from the Sattre series are nearly level to gently undulating, well drained, and silty. These soils are on outwash plains in the northwestern part of the county. They are underlain by limy, stratified sand and gravel at a depth of 24 to 42 inches.

In cultivated fields the plow layer is very dark grayish-brown silt loam about 8 inches thick. The subsoil, a dark-brown to dark yellowish-brown silt loam, is about 22 inches thick. Below is yellowish-brown sand and gravel. In undisturbed, wooded areas the surface soil is very dark gray and is less than 3 inches thick over a few inches of lighter gray subsurface soil.

These soils have a slightly acid surface soil. The subsoil is slightly acid to medium acid, and the underlying sand and gravel is calcareous. Fertility is moderately high, runoff and internal drainage are medium, and permeability is moderately rapid. The capacity to store water is moderate and causes these soils to be slightly droughty in periods of low rainfall.

Sattre silt loam, silty variant, 0 to 2 percent slopes (SeA).—The profile of this soil is similar to the one described for the series. Depth to sand and gravel generally is 24 to 36 inches.

This soil is good for crops and pasture, but it generally is slightly droughty during prolonged dry periods. Capability unit IIs–1; woodland suitability group 1; building site group 1.

Sattre silt loam, silty variant, 2 to 6 percent slopes (SeB).—This soil has smooth, fairly long slopes. Depth to sand and gravel generally is 24 to 30 inches.

Moderate moisture-supplying capacity and the hazard of erosion limit yields of corn on this soil. The soil is fair to good for crops and pasture. Capability unit IIe–4; woodland suitability group 1; building site group 1.

Storden Series

The Storden series consists of deep, rolling to hilly, well-drained soils. These soils are underlain by limy clay loam or loam glacial till. They are in the upland, mostly in the southwestern part of the county.

In cultivated fields the plow layer is very dark grayish-brown loam about 7 inches thick. The underlying material is light olive-brown and grayish-brown clay loam high in lime. The subsoil generally is thin or is lacking. If present it is brownish loam that grades to calcareous underlying material within a depth of 12 inches.

Storden soils have a surface soil that is neutral to slightly calcareous. Fertility is medium. Runoff is rapid, and moisture-supplying capacity and permeability are moderate. Internal drainage is medium. Water does not easily enter these soils, because concentration of carbonates in the profile reduces infiltration and permeability.

These soils are not well suited to row crops. They produce good yields of alfalfa if they are well managed.

In this county Storden soils are intermingled with areas of Lester soils. It was not practical to map the soils separately, and they are therefore mapped in complexes with Lester soils. A description of the Lester soils is given under the Lester series.

Storden-Lester loams, 6 to 12 percent slopes, moderately eroded (SlC2).—Soils in this complex are on short, irregular ridges and knolls. About 60 percent of the acreage is Storden loam, and the remaining 40 percent is Lester loam. These soils are more eroded than those described for their respective series. The present plow layer is a mixture of dark-gray material from the remaining surface soil and of brownish, heavier textured material formerly in the subsoil. The Lester soil generally is less than 24 inches thick over limy material. In many places barren spots of yellowish, limy clay loam are on the edges of the more abrupt slopes.

Mapped with these soils are small areas of Glencoe and Webster soils in depressions between irregular slopes.

The soils in this complex are fair for crops and good for pasture. Because of the loss of organic matter through erosion, tilth is poor and productivity lowered. The hazard of further erosion is severe if these soils are cultivated and not protected. Capability unit IIIe–1; woodland suitability group 2; building site group 5.

Storden-Lester loams, 12 to 18 percent slopes, moderately eroded (SlD2).—This complex occupies areas that have many, irregular, short ridges and knolls. About 65 percent of the acreage is Storden loam, and about 35 percent is Lester loam. These soils have lost from one-fourth to three-fourths of the original surface soil through erosion. The present plow layer is a mixture of the remaining surface soil and of material from the subsoil and is lighter colored than the original surface layer. In many places barren spots of yellowish, limy clay loam are on the edges of the steeper slopes.

These soils are fair to poor for crops and good for pasture. Because the content of organic matter is low, tilth generally is poor and productivity lowered. Water does not easily enter these soils, and they are slightly droughty during dry periods. The hazard of erosion is severe, and if these soils are cropped, intensive practices are needed to prevent further erosion. Capability unit IVe–1; woodland suitability group 2; building site group 6.

Storden-Lester Loams, 18 to 25 percent slopes, moderately eroded (SlE2).—This complex is in hilly areas. About 70 percent of the acreage is Storden loam, and the remaining 30 percent is Lester loam. The individual layers are thinner, but the profile of each soil is otherwise similar to the one described for their respective series. Areas still in pasture or woods are little eroded, but areas in crops have lost from one-fourth to three-fourths of the original surface soil through erosion. In cultivated areas there are many barren spots of yellowish loam.

Because of the steep slopes and hazard of further erosion, use of these soils is severely limited. These soils are not suited to tilled crops, but if they are well managed, they are moderately productive of hay and pasture. Capability unit VIe–1; woodland suitability group 3; building site group 7.

Storden-Lester soils, 6 to 12 percent slopes, severely eroded (StC3).—This soil complex is in strongly sloping areas that have many, short, irregular ridges and knolls. About 65 percent of the acreage is Storden soils, and about 35 percent is Lester. These soils have lost nearly all of their original surface soil through erosion. The present plow layer is yellowish brown and is mostly clay loam formerly in the subsoil. Many barren spots of yellowish, limy clay loam are on the steeper slopes.

These soils are fair to poor for crops and good for pasture. They are subject to further erosion and are therefore not suitable for continuous cultivation. Low content of organic matter and poor tilth limit productivity of these soils, and it is difficult to cultivate them and to prepare a seedbed in them. Also because water does not easily enter these soils, they are slightly droughty, and thus loss of soil and water is increased. Capability unit IVe–1; woodland suitability group 2; building site group 5.

Storden-Lester soils, 12 to 18 percent slopes, severely eroded (StD3).—About 65 percent of the acreage of this complex is Storden soils, and about 35 percent is Lester soils. These soils have lost nearly all of their original surface soil through erosion. The present plow layer is mostly yellowish-brown clay loam formerly in the subsoil. In the Lester soils depth to limy material is less than 24 inches. All areas have many barren spots of limy clay loam on the surface.

Low content of organic matter and poor tilth limit productivity of these soils. Water moves rapidly off the strong slopes, and the soils are therefore somewhat droughty during dry periods. It is also difficult to establish a seedbed in these soils. Because of the severe hazard of further erosion, this complex is not suitable for cultivation. It is best to keep the areas under a cover of permanent vegetation. Capability unit VIe–1; woodland suitability group 2; building site group 6.

Talcot Series

Soils of the Talcot series are moderately deep and are very poorly drained. They are underlain by limy gravel and sand. These soils are in shallow depressions and drainageways in outwash plains and on river terraces.

The surface layer is black clay loam about 23 inches thick. The subsoil, an olive-gray sandy clay loam mottled with light olive brown, is about 8 inches thick. Below is gray and olive-gray, limy gravel and sand.

The profile, as well as the underlying material, is slightly limy to moderately limy. Fertility is moderate. Runoff is slow, and water stands on these soils for long periods. Internal drainage and permeability are moderately slow. The water table is high, and the moisture-supplying capacity is moderately high.

If these soils are artificially drained, air and water move fairly easily through them. Undrained areas are seasonally ponded, and in wet years they may be flooded the year round.

Talcot clay loam (0 to 1 percent slopes) (Tc).—This is the only Talcot soil mapped in this county. It is in shallow basins and drainageways. Its profile is similar to the one described for the series. In a few areas variable layers of loamy material are between the underlying layers of gravel and sand.

Undrained areas of the Talcot soils are poor for wild hay or pasture. Artificial drainage is necessary if this soil is cropped. Drained areas are good for corn and soybeans, but the crop is susceptible to damage by frost. The gravelly underlying material causes problems in installing and maintaining drainage systems. Also the sandy substratum tends to cave. Capability unit IIIw–1; woodland suitability group 11; building site group 10.

Terril Series

The Terril series consists of deep, moderately well drained, loamy soils. These soils are at the base of steep slopes or are in drainageways.

The surface layer is black loam, about 28 inches thick. The subsoil, a very dark grayish-brown loam, is more than 24 inches thick. In places recent overwash material, which ranges from 12 to 30 inches in thickness, is on the surface.

Terril soils are neutral to slightly acid in the surface soil and neutral to medium acid in the subsoil. Fertility and content of organic matter are high. The moisture-supplying capacity is also high. Runoff and internal drainage are medium, and permeability is moderate.

These soils are productive, but because they occupy fairly small areas, they generally are farmed the same as adjacent steeper soils.

Terril loam, occasionally flooded, 0 to 2 percent slopes (TeA).—This soil is on bottom lands of streams. Some areas are dissected in many places by old stream channels, and these consist of short, narrow ridges and have a corrugated appearance. This soil is slightly wet or is flooded occasionally, but the floodwaters do not remain long, nor do they flow rapidly enough to cause cutting and excessive loss of soil. The soil material is somewhat variable but is mostly deep, very dark brown and dark grayish-brown loam. It ranges from slightly alkaline to medium acid. Fertility is moderately high.

This soil is good for crops and pasture. Occasional flooding is the most serious limitation to use. Capability unit IIw–2; woodland suitability group 1; building site group 11.

Terril loam, sandy substratum, 0 to 2 percent slopes (TlA).—This moderately well drained to somewhat poorly drained soil is in depressions and drainageways on sandy outwash plains and stream terraces. It consists of black loam underlain by sand and gravel at a depth of 40 to 60 inches or more. In a few places the surface soil is silty. This soil is slightly acid to medium acid. Fertility and moisture-supplying capacity are high. Artificial drainage generally is not needed, even though this soil is slightly wet in some years.

This soil is good for crops. It withstands drought better than nearby higher lying soils. Few limitations restrict its use, but the areas are mostly small. Capability unit I–1; woodland suitability group 1; building site group 8.

Terril soils, 2 to 6 percent slopes (TsB).—This mapping unit occupies gentle slopes below steeper soils. In some areas small amounts of sandy material overlie overwash of finer texture, but otherwise the profile is similar to the one described for the series.

These soils are subject to moderate erosion. Nevertheless yields of crops and pasture are good under good management. Capability unit IIe–1; woodland suitability group 1; building site group 8.

Wadena Series

The Wadena series consists of moderately deep, nearly level to rolling, loamy soils that are well drained. These soils are underlain by limy sand and gravel. They are on outwash plains and stream terraces and occupy somewhat extensive areas near the Mississippi and Crow Rivers.

The surface layer is black loam about 10 inches thick. The subsoil, a dark-brown loam, is about 15 inches thick. Below is dark grayish-brown sand and gravel.

Wadena soils are neutral to slightly acid in the surface layer and slightly acid to medium acid in the subsoil. Depth to sandy and gravelly underlying material ranges from 24 to 42 inches but generally is 24 to 30 inches. The underlying material generally is limy within a depth of 48 inches. Fertility is moderate. Runoff and internal drainage are medium, and permeability is moderately rapid. The moisture-supplying capacity is moderate.

Movement of air and water through these soils is good, and the soils are easy to keep in good tilth. Crops on these soils, however, are damaged slightly by drought during dry periods.

Wadena loam, 0 to 2 percent slopes (WaA).—The profile of this soil is similar to the one described for the series. In a few places a thin mantle of wind-drifted, sandy material overlies the surface layer. Depth to sand and gravel generally is 24 to 30 inches.

Because of moderate moisture-supplying capacity, this soil is slightly droughty. This soil is good for small grains and pasture. It is also good for corn, but in most years sufficient moisture is lacking for best yields. Capability unit IIs–1; woodland suitability group 1; building site group 1.

Wadena loam, 2 to 6 percent slopes (WaB).—This soil has short, smooth slopes. Its profile is similar to the one described for the series. Depth to sand and gravel generally is 24 to 30 inches.

This soil is subject to erosion and is slightly droughty. It is good for small grains and pasture. It is also good for corn, but in most years there is not enough moisture for best yields. Capability unit IIe–4; woodland suitability group 1; building site group 1.

Wadena loam, 2 to 6 percent slopes, moderately eroded (WaB2).—This soil has short, fairly smooth slopes. From 3 to 6 inches of the original surface layer has been removed through erosion. The present plow layer, a dark grayish-brown loam, is a mixture of the remaining surface soil and of material formerly in the subsoil. Depth to sand and gravel generally is 22 to 28 inches.

This soil is good for small grains and pasture, but in most years it lacks sufficient moisture for good yields of corn. The moisture-supplying capacity is moderate. Practices are needed for control of erosion and to prevent loss of moisture. Capability unit IIe–4; woodland suitability group 1; building site group 1.

Wadena loam, 6 to 12 percent slopes, moderately eroded (WaC2).—In most places this soil has short and fairly smooth slopes. As much as 6 inches of the original surface layer has been removed through erosion. The present plow layer, a grayish-brown loam, is a mixture of the remaining surface soil and of material from the subsoil. Depth to sand and gravel generally is 22 to 28 inches.

This soil is fair for small grains and pasture. It lacks sufficient moisture for good yields of corn. This soil is somewhat droughty and is subject to further erosion. Practices are needed to control erosion and thus prevent further loss of moisture. Capability unit IIIe–3; woodland suitability group 2; building site group 2.

Watseka Series

Watseka soils are somewhat poorly drained and sandy. They are in shallow depressions and drainageways on outwash plains and stream terraces.

The surface layer is very dark gray loamy sand about 12 inches thick. The subsoil, a dark grayish-brown loamy sand, is about 4 inches thick. Below is dark grayish-brown and light olive-brown sand.

Watseka soils are neutral to medium acid to a depth of more than 48 inches. Fertility is moderately low, and moisture-supplying capacity is low. Runoff and internal drainage are medium to slow. Permeability is rapid. The water table is seasonally fairly high.

In this county Watseka soils occur closely with Duelm soils and are mapped only in an undifferentiated unit with those soils. A description of the Duelm soils is given under the Duelm series.

Webster Series

The Webster series consists of deep, poorly drained, silty soils formed in limy glacial till. These soils occupy large areas on flats and in shallow drainageways in the upland.

The surface layer is black silty clay loam about 13 inches thick. The subsoil is dark grayish-brown clay loam that grades to olive gray mottled with olive. It is about 11 inches thick. The underlying material is olive and olive gray clay loam. A profile of Webster silty clay loam is shown in figure 14.

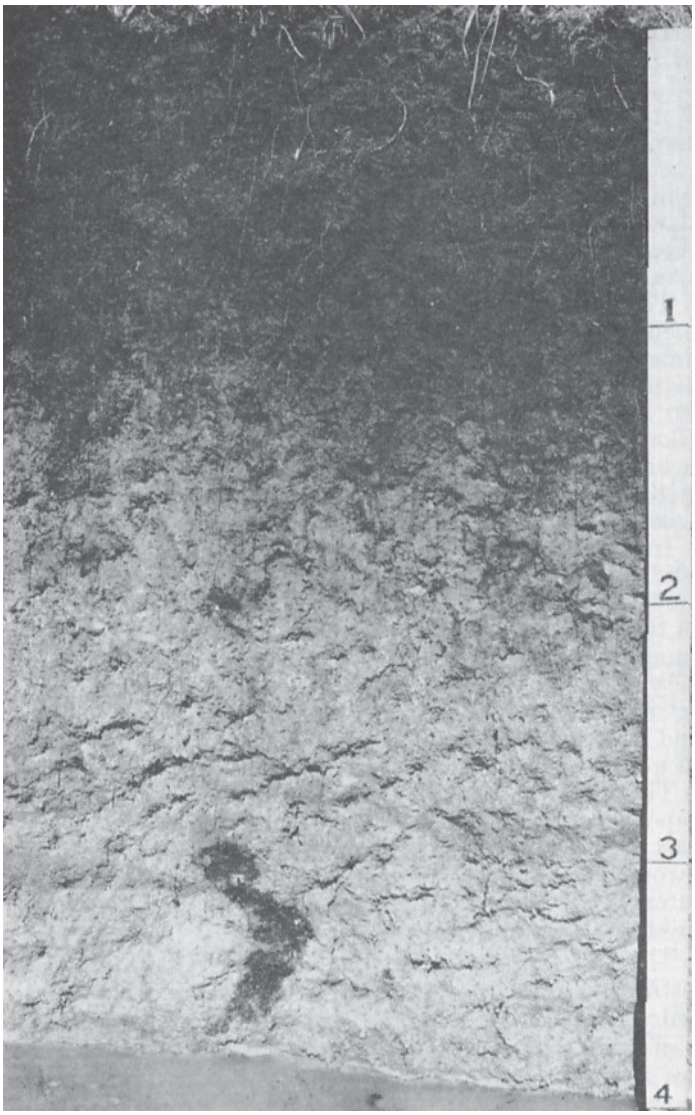

Figure 14.—**Profile of Webster silty clay loam; the units on the measure show depth in feet.**

Webster soils are neutral to slightly acid in the surface layer. Limy underlying material generally is at a depth of less than 36 inches. Fertility and content of organic matter are high. Runoff and internal drainage are slow, and permeability is moderately slow. The water table is seasonally fairly high.

Even though movement of water and air through these soils is moderately slow, tile provides adequate drainage. If drained, kept in good tilth, and otherwise well managed, these soils are good for corn and soybeans.

In this county Webster soils occur closely with Cordova soils and are mapped only in an undifferentiated unit with those soils. A description of the Cordova soils is given under the Cordova series.

Webster Series, Silty Variant

The variants from the normal Webster soils are deep, poorly drained, and silty. These soils are underlain by silty sediments laid down by water. They occupy small areas on nearly level flats and in shallow drainageways in the northwestern part of the county.

The surface layer is black silty clay loam about 16 inches thick. The subsoil, a grayish silty clay loam, is about 10 inches thick. Below is olive-gray silt loam. In places this underlying material has alternate layers of silt and very fine sand at a depth of more than 36 inches. The surface layer and subsoil range from neutral to mildly alkaline, and the underlying material generally is moderately alkaline within a depth of 36 inches. Fertility, content of organic matter, and moisture-supplying capacity are high. Runoff and internal drainage are slow, and permeability is moderately slow. The water table is seasonally fairly high.

If these soils are drained and are otherwise well managed, they produce good yields of corn and soybeans.

Webster silty clay loam, silty variant (0 to 2 percent slopes) (We).—This soil is in nearly level and slightly concave areas. Its profile is similar to the one described for the Webster variants. In a few areas the surface layer is silt loam. This soil generally is free of stones. In a few small areas the surface layer is moderately alkaline.

Excess water moderately limits use of this soil. This soil is good for crops and pasture, but drainage is needed for crops to grow successfully. If drained, good management is needed for maintaining tilth and for keeping the drainage system effective. Capability unit IIw–1; woodland suitability group 10; building site group 9.

Use and Management of the Soils

This section discusses the system of capability classification used by the Soil Conservation Service, gives the proportionate extent of soils in the county in each classification, and discusses need of the soils for lime and fertilizer. Then it discusses the capability units in which the soils are placed and gives predicted average acre yields of the principal crops. Finally it describes the

use and management of the soils for woodland and the suitability of the soils for engineering and for community developments.

Capability Groups of Soils

Capability classification is the grouping of soils to show, in a general way, their suitability for most kinds of farming. It is a practical classification based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment. The soils are classified according to degree and kind of permanent limitation, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soils; and without consideration of possible but unlikely major reclamation projects.

In the capability system, all kinds of soils are grouped at three levels, the capability class, subclass, and unit. These are discussed in the following paragraphs.

Capability Classes, the broadest grouping, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I. Soils have few limitations that restrict their use.

Class II. Soils have some limitations that reduce the choice of plants or require moderate conservation practices.

Class III. Soils have severe limitations that reduce the choice of plants or require special conservation practices, or both.

Class IV. Soils have very severe limitations that restrict the choice of plants, require very careful management, or both.

Class V. Soils subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife food and cover.

Class VI. Soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover.

Class VII. Soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to grazing, woodland, or wildlife.

Class VIII. Soils and landforms have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes.

Capability Subclasses are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only subclasses indicated by *w*, *s*, and *c*, because the soils in it are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

Capability Units are soil groups within the subclass. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–4 or IIIe–5. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation, and the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph. The Arabic numeral specifically identifies the capability unit within each subclass.

In this county 2 percent of the land area is in class I, 42 percent is in class II, and 32 percent is in class III. Of the remainder, 6 percent is in class IV and 5 percent is in class VI. Classes V, VII, and VIII account for 3 percent each of the land area. Unclassified land, consisting of land in villages, roads, cemeteries, and other similar uses, accounts for 4 percent of the land area. On about 51 percent of the land area, erosion is a problem. Wetness is a problem on about 30 percent of the land area, and drought on about 19 percent.

The soils in Wright County vary considerably in their need for lime and fertilizer. Some of the soils need lime to bring the reaction to the level at which other plant foods will be available. Other soils, such as Canisteo silty clay loam, are mildly alkaline to moderately alkaline and adding lime would be harmful to crops. It is best to have the soils tested once during the cropping system, or about every 3 to 5 years, to determine the need for lime and fertilizer.

In general, Hayden, Lester, and other soils in the upland are medium to moderately high in phosphate and moderately low to medium in potash. Sandy soils, such as the Hubbard loamy sands, are deficient in potash and generally need lime. Webster, Glencoe, and other wet silty clay loams generally are high in organic matter and nitrogen. Wet soils warm up slowly in spring, however, and a starter fertilizer that contains nitrogen is needed to get the crops off to a fast, early start.

The kind and amount of fertilizer and the lime needed depend on the kind of soil, the crops to be grown, and past management. Reliable soil tests can be obtained through the University of Minnesota Soil Testing Laboratory, which provides laboratory analyses and interprets the results of the tests.

The soil map is useful in obtaining soil samples for testing because it shows the boundaries of the different soils. Reliable test results cannot be obtained if samples from different kinds of soils are mixed together or are from the same kind of soil that has had widely differing management. The largest soil area that should be represented by one soil sample is about 10 acres. Further information about taking samples for soil test-

ing can be obtained from the county agent or from the local representative of the Soil Conservation Service.

In the following pages the capability units in Wright County are described and suggestions for the use and management of the soils are given. Soil series names are mentioned in each capability unit, but this does not imply that all mapping units of this series are in that particular unit. The "Guide to Mapping Units" at the back of the report lists the soils in each unit.

Capability unit I–1

In this unit are deep, moderately well drained to somewhat poorly drained, nearly level loamy soils of the Guckeen, Lester, Le Sueur, and Terril series. These soils are on flats and in draws. Their subsoil is medium textured or moderately fine textured. Natural fertility and moisture-supplying capacity are high. The root zone is deep, and the movement of air and water into and through the soils is favorable for the growth of plants.

These soils are among the most productive in the county. They are used intensively for corn and soybeans and are well suited to these crops. They are also well suited to small grains and to alfalfa or other hay and pasture crops. If good tilth is maintained, plant nutrients are used more efficiently and the soils are easier to work. Practices are needed that promote movement of air and water into and through the soils and that return large amounts of crop residues.

Good tilth can be maintained if the cropping system includes grass-legume meadow 1 year in 6 and if practices are used that maintain fertility and the content of organic matter. Corn can be grown continuously if the optimum number of plants per acre is seeded and large amounts of fertilizer are applied. Tillage must be kept to a minimum and done when the moisture content of the soils is favorable. Returning all crop residues directly or through bedding and grazing helps to maintain soil tilth and fertility.

If row crops are planted, tillage should be limited to that necessary for preparing the seedbed and controlling weeds. When fall plowing is done, leave the field rough through winter. Wheel-track planting of corn reduces soil compaction, which is likely if row crops are grown intensively.

In many areas the soils of this unit are in permanent pasture that is partly wooded or is brushy. Returns are more profitable if these areas are cleared and are used for rotation crops or pasture. Alfalfa, bromegrass, orchardgrass, and similar legumes and grasses are suitable pasture plants if adequate fertilizer is applied.

Edges of fields and odd-shaped areas can be planted to shrubs and trees that provide food and cover for wildlife. Honeysuckle, lilac, crabapple, and similar plants are shrubs suitable for planting. Trees suitable for planting are white spruce, white pine, Russian-olive, and redcedar.

Small, fairly dense, brushy stands of trees are on some of the soils in this unit. These areas could be cleared of trees and used as cropland.

Capability unit IIe–1

In this unit are deep, moderately well drained, gently sloping, loamy soils of the Guckeen, Le Sueur, and Terril series. These soils are similar to the soils in capability unit I–1, but they are more sloping and more susceptible to erosion. Permeability is moderate to moderately rapid, and the moisture-supplying capacity is high. These soils are productive if well managed. Controlling erosion and maintaining the soils in good tilth are the main problems of management.

The soils in this unit are well suited to corn, soybeans, and small grains. They also are well suited to alfalfa and other hay or pasture crops. In many places where these soils are intermingled with other soils or are in odd-shaped areas, the cropping system ought to be the same as that used on the adjacent soils.

In most areas in this unit, erosion can be controlled if hay is grown for 1 year in every 4 and practices are used that maintain fertility and the content of organic matter. Where slopes are more than 75 feet long, the cropping system ought to provide grass-legume meadow for 2 years in 5. Returning all crop residues to the soil helps to improve tilth and to maintain the content of organic matter. If row crops are grown, wheel-track planting and minimum tillage help to reduce erosion and soil compaction.

Contour stripcropping and terracing generally are not suitable for these soils, because slopes are short and internal drainage is slightly restricted. If such practices are used, the strips and terraces should be planted slightly off the contour.

Use and management of these soils for permanent pasture, as woodland, and for wildlife are the same as for soils of capability unit I–1.

Capability unit IIe–2

In this unit are deep, well-drained, gently sloping loams and silt loams of the Lester series. These soils are in the upland. They are moderately permeable and hold moisture well. The hazard of erosion is slight or moderate. Some of the soils are moderately eroded.

These soils are productive if practices are used that prevent erosion and maintain fertility and tilth. They are suited to all crops generally grown in the county. Corn, soybeans, small grains, and alfalfa for hay are the main crops.

If feasible, all tillage on these soils should be across the slope and on the contour. In areas where slopes are fairly uniform and are more than 300 feet long, terracing or stripcropping effectively control erosion. These practices are not suitable in many areas where slopes are complex or are short and irregular. On slopes of this kind, hay crops are needed for one-third of the time for control of erosion.

Where practices for controlling erosion can be used, the cropping system depends on the kind of practice. If contour cultivation only is used, a suitable cropping system includes 2 years of grass-legume meadow in 5 years. Contour stripcropping, with the alternate strips in grass-legume meadow for 2 years in 4 or 5 years, also is a satisfactory system. If terraces are used, a suitable cropping system includes 1 year of meadow in 6 years.

Terracing controls erosion more effectively than other practices and therefore permits more intensive use of the soils. A year before the terraces are built, waterways should be constructed and seeded to grass to provide outlets for the terraces. If the waterways are properly

designed and are kept in grass, they remove water safely and prevent gullying.

The content of organic matter generally is low in the moderately eroded soils, and large amounts of manure should be applied. Also, legumes and grasses should be grown more often than on the uneroded soils. Returning all crop residues to the soils helps to improve tilth and to maintain fertility and the content of organic matter. Wheel-track planting of row crops and use of minimum tillage reduce erosion and soil compaction.

The soils in this unit are good for permanent pasture, but yields are more profitable if the areas are used for rotation pasture or for crops. Many of the pastures produce poor forage because they are partly woody, are brushy, or are overgrazed. If pastures of tall grass are well managed and well fertilized, they produce more forage than pastures in native bluegrass. A suitable mixture for seeding pastures consists chiefly of alfalfa and bromegrass but includes a small percentage of orchardgrass.

Edges of fields and odd-shaped areas can be planted to evergreens, shrubs, legumes, and grasses to provide food and cover for wildlife. Trees suitable for planting are white spruce, white pine, redcedar, and Russian-olive. Honeysuckle, lilac, crabapple, and similar shrubs are also suitable.

Most wooded areas on soils of this unit are used for pasture (fig. 15). Use would be more economical if these areas were cleared and seeded to crops and rotation pasture. If the areas are used as woodland, the trees must be protected from grazing and fire.

Capability unit IIe–3

In this unit are deep, well-drained and moderately well drained nearly level and gently sloping, loamy soils of the Hayden, Milaca, and Nessel series. These soils are in the upland. Most of them are moderately permeable and have high moisture-supplying capacity, but the Hayden fine sandy loams are more likely to be droughty than the other soils, because their surface layer and the

***Figure 15.*—Wooded pasture on gently rolling Lester soils in capability class II; the dominant trees are hard maple, American elm, basswood, and oak.**

upper part of their subsoil is more sandy. All of the soils in this unit are low in content of organic matter, but they are productive if well managed. The hazard of erosion is slight to moderate, and some of the soils are moderately eroded.

These soils are well suited to corn, soybeans, small grains, alfalfa, and all other crops grown in the county. Practices are needed that return large amounts of crop residues to these soils and thus build up the content of organic matter, maintain soil fertility, and promote movement of air and water into and through the soils.

On the nearly level soils, good tilth can be maintained if the cropping system includes grasses and legumes 1 year in 6 and if practices are used that maintain fertility and the content of organic matter. Yields of corn are good if the optimum number of plants per acre is seeded and large amounts of fertilizer are applied. Tillage must be kept to a minimum and done when the moisture content is favorable. Return all crop residues to the soils directly or through bedding and grazing.

On the sloping soils in this unit, contour strips, terraces, or contour farming are needed for control of erosion. Also needed are a suitable cropping system, adequate amounts of fertilizer, and return of all crop residues to the soils. Practices for control of erosion on the Nessel soils should be placed slightly off the contour because internal drainage in those soils is restricted. A suitable cropping system, if contour stripcropping or contour farming is used, is 2 years of grass-legume meadow in 5 years. If terraces are used, a suitable system includes 3 years of row crops, 1 year of small grain, and 1 year of meadow.

In many places slopes are uneven or are too complex for contour farming. On these erosion can be controlled if a suitable cropping system is used and if row crops are wheel-track planted, large amounts of fertilizer are applied, and all crop residues are returned to the soils. In one such system a row crop is grown 1 year in 4.

Terracing more effectively controls erosion than other practices, and therefore permits more intensive use of the soils. Graded terraces generally are built. A year before the terraces are built, waterways should be constructed and seeded to grass to provide outlets for the terraces. If the waterways are properly designed and are kept in grass, they remove the water safely and prevent gullying.

Most soils in this unit are low in content of organic matter. Applying large amounts of manure, returning all crop residues to the soils, and growing legumes and grasses frequently increase the content of organic matter and improve tilth and fertility.

Soils in this unit are well suited to pasture. Areas used as pasture should be cleared of trees and brush and used for rotation pasture. More forage is produced on well-managed and well-fertilized pasture of tall grass, such as alfalfa and bromegrass that contain a small percentage of orchardgrass, than on permanent pasture consisting of native bluegrass.

Edges of fields and odd-shaped areas can be planted to evergreens, shrubs, legumes, and grasses to provide food and cover for wildlife. Suitable trees for planting are white spruce, white pine, redcedar, and Russian-olive. Honeysuckle, lilac, crabapple, and similar shrubs are also suitable.

Some fairly dense stands of brushy hardwoods are on these soils, and most are pastured. Use would be more economical if these areas were cleared and seeded to crops and rotation pasture.

Capability unit IIe–4

This unit consists of gently sloping, well-drained loams and silt loams of the Fairhaven, Estherville, Lester, Sattre, and Wadena series. Most of these soils are underlain by sand and gravel at a depth of 24 to 36 inches, but the soils in the Lester-Estherville complexes are underlain by sand and gravel at this depth and deeper. All of these soils have moderately rapid permeability and moderate water-supplying capacity.

These soils warm up fairly early in spring and generally are easy to till, but because they are moderately deep to sand and gravel, they are slightly droughty. Also these soils are subject to erosion, and some are moderately eroded.

If the supply of moisture is adequate and these soils are well managed, yields of corn and soybeans are good. These soils also are suited to small grains and to hay and pasture.

Because of the hazard of erosion, these soils ought to be farmed on the contour or across the slope wherever feasible. If contour tillage alone is used, a suitable cropping system on most slopes includes 1 year of grass-legume meadow in 4 years. In a few places slopes are long, and here contour stripcropping, with the alternate strips in grass-legume meadow 2 years in 4, provides good control of erosion. If more row crops are needed in the cropping system, 2 years of grass-legume meadow in 5 years is also satisfactory. If terraces are used and if all crop residues are returned to the soil and fertility is maintained, a suitable cropping system is 1 year of meadow in 5.

Terracing controls erosion more effectively than other practices and permits more intensive use. For soils in this unit, uniformity of depth to the substratum should be checked before terraces are constructed. A year before the terraces are built, waterways should be constructed and seeded to grass to provide outlets for the terraces. If the waterways are properly designed and are kept in grass, they prevent gullying.

In areas where slopes are very uneven, contour farming is not feasible. In such areas a cropping system that includes 2 years of grass-legume meadow in 5 years generally provides protection from erosion and maintains the soil.

The moderately eroded soils generally are low in content of organic matter and nitrogen. These soils require large amounts of manure and more legumes and grasses in the cropping system than other soils in this unit. They can be plowed in spring or fall, but if plowed in spring, plow-planting of row crops reduces compaction and helps to control erosion.

Soils in this unit are fairly good for pasture, but supplemental pasture generally is needed during prolonged dry periods. More forage is produced on well-managed and well-fertilized pasture of tall grasses and legumes, such as those that are made up chiefly of alfalfa and

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bromegrass and that include a small percentage of orchardgrass, than is produced on permanent bluegrass pasture. Bluegrass pasture normally grows little in midsummer because moisture is lacking. Grazing must be rotated to give the plants time to recover. Some pastures are poor because they are partly wooded or are brushy.

Winter cover generally is lacking in areas of these soils, and odd corners, old gravel pits, and adjacent areas should be developed for wildlife. Legumes, grasses, shrubs, and evergreens that resist drought are suitable for planting.

These soils generally are not used for woodland, and the few areas that are wooded are pastured. Stands are poor and consist of various kinds of hardwoods.

Capability unit IIw–1

This unit consists of poorly drained to moderately well drained, loamy soils on flats and in small drainageways. These soils are of the Biscay, Canisteo, Cordova, Le Sueur, Marna, and Webster series. Most of them are deep and silty and have moderately slow to slow permeability. Biscay loam, however, is 24 to 36 inches thick over gravel and sand and has moderate permeability. The unit consisting of Cordova and Le Sueur silty clay loams is made up of poorly drained Cordova soils and of moderately well drained Le Sueur soils. The moisture-supplying capacity and fertility of all soils in this capability unit are high. The seasonal water table is fairly high, and some sites are desirable for stock water ponds.

If these soils are properly drained and otherwise well managed, they are among the most productive in the county. Keeping them in good tilth is important in the maintenance of drainage systems and in the efficient use of plant nutrients.

Good yields depend on an adequate system of tile drains. If these soils are adequately drained, they are suited to all crops grown in the county. They are especially suited to corn and soybeans. Practices that promote movement of water and air into and through the soils and that return large amounts of crop residues are needed.

If these soils are adequately drained and fertilized and all crop residues are returned, row crops can be grown extensively. Good tilth can be maintained if a cropping system includes a grass-legume mixture for meadow 1 year in 6 and if practices that maintain fertility and the content of organic matter are used. Row crops can be grown continuously if management is especially good. Yields are good if the optimum number of plants per acre is seeded and large amounts of fertilizer are applied. Tillage must be kept to a minimum and done when the moisture content of these soils is favorable. Crop residues need to be returned to the soils directly or through bedding and grazing.

On these soils fall plowing insures that a good seedbed can be obtained in spring. If these soils are plowed when wet, clods form that are difficult to break, and compaction is likely. Returning all crop residues to the soils, applying manure, and growing legumes and grasses are ways for maintaining tilth and fertility and for improving drainage.

Most permanent pastures on soils in this unit are partly wooded, are brushy, and are not drained. Yields are more profitable if these soils are used for rotation crops after they are cleared and tiled to provide drainage. Pasture is also a good use because these soils hold moisture well throughout the growing season. Yields of forage are good on well-managed pasture consisting of a tall grass-legume mixture or of native bluegrass. A suitable mixture is bromegrass, red clover, and alsike. Grazing needs to be delayed until the soils are firm.

Odd-shaped areas and borders of fields can be planted to evergreens, shrubs, legumes, and grasses to provide food and cover for wildlife. Red clover and alsike clover are the best legumes for this use. Evergreens suitable for planting are white spruce, white pine, and redcedar. Russian-olive also is suited. Honeysuckle, lilac, and crabapple are shrubs that are suitable.

Soils in this unit are more valuable as cropland than as woodland. Consequently few areas are wooded, though fairly dense stands of brushy hardwoods grow on some areas of the Cordova soils.

Capability unit IIw–2

This unit consists of moderately well drained loams of the Becker and Terril series. These soils are on bottom lands along streams. They are slightly wet or are flooded occasionally, depending on the season, but the hazard is not enough to prevent using the areas for crops. Fertility and moisture-supplying capacity are moderately high to high. Permeability is moderate.

If adequate fertilizer is applied and these soils are otherwise well managed, yields of corn and soybeans are good. These soils are also used for small grains, though in places lodging is a problem during wet years. Floods are likely to delay planting in spring, and crops on these soils start growing more slowly than on better drained soils.

Returning all crop residues to these soils and growing sod crops and cover crops occasionally help to maintain tilth and the content of organic matter. In places where streams meet or the turn of the stream is sharp, such practices as planting of willows are needed to stabilize the banks.

Soils in this unit hold moisture well throughout the growing season and generally are suitable for pasture. Pasture of tall grasses and legumes or of native bluegrass that is well managed is also good for grazing. Some areas are poor for pasture because they are wooded or are brushy.

Wildlife can be encouraged by seeding plants that provide food and cover. Red clover and alsike clover are suitable legumes for planting, and white spruce, white pine, and redcedar are suitable evergreens. Russian-olive is well adapted, and honeysuckle, lilac, and crabapple are some shrubs that are suited. Small, wet areas can be planted to willows and reed canarygrass.

Capability unit IIs–1

This unit consists of well-drained, nearly level loams and silt loams of the Fairhaven, Sattre, and Wadena series. These soils are underlain by sand and gravel within a depth of 24 to 36 inches. Permeability is moderately rapid, and natural fertility is high. These soils are

easy to till and warm up fairly early in spring, but they are slightly droughty. Yields are favorable if sufficient moisture is available during the growing season. Moderate depth to sand and gravel, however, makes the soils capable of holding in the upper 5 feet only from 6 to 9 inches of water that plants can use.

If the supply of moisture is adequate and these soils are well managed, yields of corn and soybeans are good. These soils also are suited to small grains and to hay and pasture. All crops on these soils respond well to irrigation.

Row crops can be grown intensively on these soils. Maintaining soil tilth generally is not a problem, but all crop residues should be returned to the soils to improve moisture capacity and fertility. A suitable cropping system ought to be used with practices that maintain fertility and the content of organic matter. In one such system grass-legume meadow is grown for 1 year in 6. Corn can be grown continuously if these soils are well managed. Yields are good if moisture is adequate during the growing season and the optimum number of plants per acre is seeded. Large amounts of fertilizer are needed, and tillage must be kept to a minimum.

These soils can be plowed in fall or in spring. If they are plowed in spring, plow-planting of row crops reduces compaction and helps to control erosion.

The soils in this unit are well suited to pasture, but many of the pastures produce poor forage because they are partly wooded and brushy. Suitable plants for permanent pasture are mixtures consisting mainly of bluegrass or alfalfa and bromegrass that include a small percentage of orchardgrass.

Food and cover for wildlife can be provided by planting evergreens, shrubs, legumes, and grasses. Trees suitable for planting are white spruce, white pine, redcedar, and Russian-olive. Suitable shrubs are honeysuckle, lilac, and crabapple.

These soils are also suitable for woodland. Protection from grazing and fire is required, but most areas now in trees lack such protection.

Capability unit IIIe–1

This unit consists of deep, well-drained, moderately sloping, loamy soils of the Guckeen, Lester, and Storden series. Most of the soils are moderately permeable, but the Guckeen soil is more clayey than the others, and water and air move more slowly through it. The moisture-supplying capacity and natural fertility are high in all the soils. In most cultivated areas, these soils have lost from one-half to three-fourths of their original surface soil through erosion. The hazard of further erosion is severe.

If these soils are well managed, they are productive. Alfalfa and other hay or pasture crops are well suited. Row crops, including soybeans, should not be grown unless practices are used that control erosion and maintain fertility. Cropping systems that provide for frequent use of legumes and grasses are needed. All crop residues should be returned to the soils, adequate fertilizer applied, and large amounts of manure added.

Contour stripcropping, with the alternate strips in meadow, can be used in many places for control of erosion (fig. 16). Terraces also can be used. A year before

Figure 16.—**Turnstrip at the end of contour strips on a Lester loam that has a slope of 10 percent.**

the terraces are built, construct and seed waterways so that outlets are protected. If the waterways are properly designed and are kept in grass, they remove water safely and prevent erosion. When terraces are used, a suitable cropping system includes meadow for 1 year in 4. Contour tillage or tillage across the slope can be used for control of erosion in areas that have short, irregular slopes, or in other areas where stripcropping or terracing is not practical. In such areas a suitable cropping system includes meadow 2 years in 4. On soils not terraced or stripcropped, row crops can be plow planted. The sides of all waterways and gullies in these soils should be shaped, seeded with grass, and then kept in grass or other permanent vegetation. In the eroded soils the supply of nitrogen and content of organic matter generally are low.

Soils in this unit are fairly good for pasture, but supplemental pasture generally is needed during prolonged dry periods. More forage is produced on pasture consisting of tall grass and legumes, such as pasture made up chiefly of alfalfa and bromegrass and that includes a small percentage of orchardgrass, than is produced on permanent pasture containing bluegrass. Bluegrass pasture normally grows little in midsummer because moisture is lacking. Grazing must be rotated to give the plants time to recover. Some pastures are poor because they are partly wooded or are brushy.

Odd corners, old gravel pits, and adjacent areas should be developed for wildlife, since winter cover generally is lacking on these soils. Legumes, grass, shrubs, and evergreens that resist drought are suitable for planting.

These soils generally are not used for woodland, and the few areas that are wooded are pastured. Stands are poor and consist of various kinds of hardwoods.

Capability unit IIIe–2

This unit consists of deep, sloping, well-drained Hayden loams and fine sandy loams. These soils formed under hardwoods, and they have a thinner surface layer that generally is lower in content of organic matter than

that of soils in capability unit IIIe–1. They are also somewhat more acid and have a more clayey subsoil.

In all these soils permeability is moderate and the water-supplying capacity is moderately high. The fine sandy loams are somewhat less resistant to drought than the loams in this unit. Fertility is moderate in all these soils, and crops on these soils respond well if fertilizer is added and other good management is used. The hazard of erosion is severe if these soils are not protected. Soils in areas used mostly for permanent pasture or woodland are only slightly eroded, but most soils in cultivated areas have lost from one-half to three-fourths of their original surface layer through erosion and generally are in poor tilth.

These soils are fair for row crops, but they are well suited to alfalfa and other plants grown for hay or pasture. If row crops are grown, a suitable cropping system is needed, along with adequate amounts of fertilizer and other good management practices for control of erosion and for maintaining fertility and improving tilth. Farming on the contour, stripcropping, or terracing is also needed.

Contour stripcropping, with the alternate strips in meadow, can be used in many places for effective control of erosion. Terraces also can be used if they can be adjusted to the slope, and they are more effective for controlling erosion than other practices. A year before the terraces are built, waterways should be constructed to provide outlets for the terraces. If the waterways are properly designed and are kept in grass, they remove water safely and prevent erosion. When terraces are used, a suitable cropping system includes hay for 1 year in 4.

Contour tillage or tillage across the slope can be used for control of erosion where slopes are short or irregular and are not suitable for stripcropping or terracing. In such areas a suitable cropping system includes 3 years of meadow in 5. Wheel-track planting of corn also is needed in these areas. The sides of waterways and gullies should be shaped, seeded to grass, and then kept in grass or other permanent vegetation.

Because the content of organic matter is low, all crop residues must be returned to these soils. Applying large amounts of manure and keeping the soils in grasses and legumes help to restore tilth and fertility and to protect the soils from erosion.

These soils are well suited to pasture, though many of the pastures produce poor forage because they are partly wooded or are brushy. More forage is produced on pasture made up of tall grasses and legumes, such as bromegrass and alfalfa, than on pasture consisting of permanent bluegrass. Bluegrass grows little in midsummer because moisture is lacking. Tall-grass pasture should be divided into fields and the grazing rotated from field to field. For control of erosion, avoid grazing early in spring and late in fall, as well as overgrazing.

Some areas of these soils are suitable sites for impounded farm ponds. Odd areas and borders of fields can be planted to provide food and cover for wildlife. Russian-olive, honeysuckle, crabapple, and lilac are suitable for planting. Suitable evergreens are white spruce, white pine, and redcedar.

Some of these soils have fairly dense stands of unmanaged hardwoods on them. Few of these areas are protected from grazing or fire.

Capability unit IIIe–3

In this unit are sloping, well-drained, moderately eroded, loamy soils of the Fairhaven and Wadena series. These soils are underlain by sand and gravel at a depth of 24 to 36 inches. In most cultivated areas they have lost from one-half to three-fourths of their original surface layer through water erosion. Areas in permanent pasture or woods are little eroded.

These soils are easy to till, but because of the slopes, the hazard of further erosion is severe. Fertility is moderately high, and permeability is moderately rapid. The capacity to hold water is moderate, and these soils are slightly droughty during prolonged dry periods. Also because of erosion, the content of organic matter is low in most places.

If these soils are well managed, they are suitable for row crops. Yields are limited because of the moderate moisture-supplying capacity.

Wherever feasible these soils ought to be farmed on the contour or across the slope for control of erosion and conservation of water. The cropping system depends on the kind of practice. If contour tillage or farming across the slope is used, a suitable cropping system includes 3 years of grass-legume meadow in 5 years. Plow-planting of row crops also helps to conserve soil and water. Contour stripcropping, with alternate strips in grass-legume meadow 2 years in 4, also provides good protection from erosion. If terraces are used, a suitable cropping system is 1 year of grass-legume meadow in 4.

Terracing controls erosion more effectively than other practices, but for these soils, uniformity of depth to the substratum must be checked before terraces are constructed. A year before the terraces are built, waterways should be constructed and seeded to grass to provide outlets for the terraces. If the waterways are properly designed and kept in grass, they remove excess water safely and prevent erosion.

Gullies in these soils should be shaped and seeded to grass for use as waterways. It is difficult, however, to control gullies once they have started in these soils because of the moderate depth to sand and gravel.

Soils in this unit provide good pasture early in the season, but because of slight droughtiness, they generally do not produce all the forage needed in midsummer. More forage is produced on pastures of tall grass, such as alfalfa and bromegrass, than on pasture of permanent bluegrass.

Bluegrass pasture normally grows little in the dry, hot months because moisture is lacking. Pasture of tall grass should be divided into fields and grazing rotated from field to field. Some pastures are poor because they are wooded or are brushy. If these were cleared of trees and brush, yields of forage would increase. Controlling weeds and rank growth also helps to conserve moisture and thus improves yields.

Winter cover for wildlife generally is lacking on these soils, and odd corners, old gravel pits, and surrounding areas ought to be developed for wildlife areas. Legumes,

grasses, shrubs, and evergreens that resist drought are suitable for planting. These soils generally are not used for woodland.

Capability unit IIIe–4

This unit consists of gently sloping, somewhat excessively drained sandy loams and loamy sands of the Hubbard and Rasset series. These soils are underlain by sand within a depth of 24 inches. Some of them are moderately eroded.

These soils warm up early in spring and are easy to till. Crops on them respond well if fertilizer is added. They are droughty, however, and are subject to further erosion. The moisture-supplying capacity is low, fertility is moderate, and permeability is moderately rapid.

If rainfall is adequate throughout the growing season, fertilizer is added, and other good management is used, soils in this unit are suitable for all crops grown in the county. Crops on these soils respond well to irrigation. The surface layer is sandy and erodes readily, and plowing therefore should be done in spring. A suitable cropping system, minimum tillage, and stubble mulching are needed. Also keep the surface rough between crops or under cover crops and return all crop residues to the soils. All these practices improve the supply of moisture and reduce erosion.

Contour stripcropping, with the alternate strips in grass-legume meadow, effectively controls wind and water erosion. If contour stripcropping is not practical, farming can be done on the contour or across the slope, and a suitable cropping system would include 2 years of grass-legume meadow in 5 years. If terraces are used, a suitable cropping system is 1 year of grass-legume meadow in 4.

Terraces generally are not needed on these soils if a suitable cropping system is used, but diversion ditches are needed in some places where slopes are long. Level terraces are suitable for most of the soils, but the substratum should be checked before terraces are constructed.

The moderately eroded soils are low in content of organic matter and generally are low in nitrogen. They can be improved if large amounts of manure are applied and legumes and grasses are grown in the cropping system.

On these soils, grazing the second year of meadow in the cropping system is better than maintaining permanent pasture. Permanent pasture is productive in spring and early in summer, but it dries up or does not grow at all in the hot summer months. More forage is produced on pasture consisting of tall grass, such as bromegrass and alfalfa, than on pasture of permanent bluegrass. Permanent pasture made up of tall grasses should be divided into fields and grazing rotated from field to field.

Cover for wildlife generally is lacking on soils in this unit. Clover and birdsfoot trefoil can be planted to provide food for deer and nesting cover for pheasant. Around sand pits and in odd-shaped areas, evergreens, shrubs, legumes, and grasses that resist drought can be planted.

Soils in this unit generally are not wooded, but they are well suited to evergreens.

Capability unit IIIe–5

This unit consists of shallow, somewhat excessively drained, nearly level and gently sloping sandy loams and loams of the Burnsville, Emmert, Estherville, Hayden, and Milaca series. Some of these soils are moderately eroded.

The gravel and sand that underlies the soils in this unit is coarser textured than that of soils in capability unit IIIe–4 and is more restrictive to root growth. In many places the Burnsville soils and the soils in the Emmert-Milaca complex have large stones on the surface and throughout the profile.

In all of these soils permeability is moderately rapid, the moisture-supplying capacity is low, and fertility is moderate to moderately low. These soils warm up early in spring. They are easy to till except in areas that are stony, but they are droughty and are subject to moderate erosion. Crops on these soils respond well if fertilizer is applied.

If adequate moisture is available throughout the growing season and if fertilizer is applied and other good management is used, these soils are suitable for all crops grown in the county, and yields are good. Crops on these soils respond well to irrigation. In winter a protective cover of stubble or grass is needed for control of wind erosion. Returning all crop residues improves fertility and the supply of moisture and reduces erosion. Plowing in spring and keeping all tillage to a minimum are desirable practices.

In the nearly level areas, wind stripcropping and a cropping system that includes meadow 1 year in 4 effectively controls erosion. In sloping areas, contour stripcropping and a cropping system in which alternate strips are in grass-legume meadow 2 years in 4 are satisfactory. Contour tillage or tillage across the slope can be used for control of erosion in areas where contour stripcropping is not practical. In such areas a suitable cropping system includes meadow 2 years in 5. Because these soils are shallow to gravel and sand, terraces generally are not used. Diversion ditches can be used, however, in places on long slopes for protection from erosion. Areas where water concentrates need to be shaped and seeded to grass to prevent gullying.

The moderately eroded soils are low in organic matter and generally are low in nitrogen. They can be improved if large amounts of manure are applied and if legumes and grasses are grown in the cropping system.

Grazing the second year of meadow in the cropping system is better than maintaining permanent pasture on these soils. Pasture on these soils is productive early in the season, but it dries up or does not grow in the hot summer months. More forage is produced on pasture consisting of tall grasses, or of bromegrass and alfalfa, than on pasture of permanent bluegrass. Permanent pasture made up of tall grasses should be divided into fields, and the grazing rotated from field to field.

Cover for wildlife generally is lacking on many soils in this unit. Clover and birdsfoot trefoil can be planted to provide food for deer and nesting cover for pheasants. Around gravel pits and in odd-shaped areas, evergreens, shrubs, legumes, and grasses that resist drought can be planted.

All soils in this unit are well suited to evergreens. On the Burnsville soils and on soils in the Emmert-Milaca complex are tracts of hardwoods or brush that are pastured.

Capability unit IIIw-1

This unit consists of very poorly drained soils of the Blue Earth, Glencoe, and Talcot series and of Clayey basin land in basins and along the borders of lakes. These soils are in depressions and drainageways. Most of them are deep and silty, but the Talcot soil is underlain by sand and gravel within a depth of 24 to 42 inches, and Clayey basin land consists of deep silty clay. Fertility and moisture-supplying capacity of all the soils are high. Permeability is moderately slow to slow. Excess water severely limits use, and maintenance of tilth is a problem if these soils are cropped.

Drainage is necessary before these soils are used for crops (fig. 17). Tile drainage is suitable if outlets for

Figure 17.—**Corn on a ponded Glencoe soil; the crop could have been saved if tile drainage had been installed.**

the tile are available. In areas where large quantities of water must be removed, open ditches generally are used to provide drainage. If these soils are adequately drained and fertilized, yields of corn and soybeans are high. Varieties that mature early should be planted because of the hazard of frost. Oats can be grown if these soils are drained, but lodging generally is a serious problem. These soils generally are not suited to alfalfa, but if they are adequately drained, red clover, alsike clover, ladino clover, bromegrass, and timothy are suitable.

If these soils are drained, a cropping system that includes grasses and deep-rooted legumes helps to increase the efficiency of the drainage system and to maintain tilth and fertility. A suitable cropping system is 1 year of meadow in 6 years if practices are used to maintain fertility and the content of organic matter. Corn can be grown continuously if good drainage is provided and the soils are otherwise well managed. Yields are good if the optimum number of plants per acre is seeded and large amounts of fertilizer are applied. Also tillage must be kept to a minimum and done when the moisture content is favorable. All crop residues need to be returned to the soils directly or through bedding and grazing.

Pasture in undrained areas can be improved by plowing early in fall when the soils are dry enough to work. It is best to seed reed canarygrass, timothy, and similar grasses in fall and to broadcast suitable legumes over the areas in spring. Defer grazing until the soils are firm. Most areas are good sites for stock water ponds.

Undrained areas of these soils generally are marshy and seasonally ponded. These areas are good habitats for ducks, pheasants, muskrats, and similar kinds of wildlife. They can be improved for wildlife by use of shallow pits and level ditches. Banks of drainage ditches and the edges of ponds used to provide water for livestock can be seeded to grasses and legumes to furnish food and cover for wildlife. Grazing or mowing of banks of ditches should be delayed until after July 15 to protect nesting wildlife. All wildlife areas must be protected from fire.

Many soils in this unit have a sparse stand of willows and alders on them. These soils, however, generally are not suitable for use as woodland.

Capability unit IIIw-2

In this unit are deep, somewhat poorly drained and poorly drained, nearly level, silty soils of the Ames and Dundas series. These soils have a subsoil of silty clay or clay. They are on flats in the upland. Permeability is slow, and the moisture-supplying capacity is high. The content of organic matter generally is low, and fertility is moderate. Wetness severely limits use, because the clayey subsoil restricts movement of water and limits the success of artificial drainage.

Soils in this unit are suited to all crops grown in the county, but drainage and good management are needed for good yields. Because use of tile for drainage is limited by the slow permeability of the subsoil, surface inlets generally are needed to improve drainage in the small depressions that occur within areas of these soils.

If tile is used to provide drainage, a cropping system that includes deep-rooted legumes and grasses helps to increase the efficiency of the drainage system. A suitable cropping system includes 1 or 2 years of meadow in 5 years. All crop residues need to be returned to the soils, and large amounts of manure must be applied to increase the content of organic matter and to maintain fertility.

These soils hold moisture well throughout the growing season and are good for pasture. Many pastures, however, are poor because they are partly wooded or are brushy (fig. 18). If these areas are cleared and well managed, they provide good grazing when planted to such tall grasses and legumes as bromegrass and alfalfa, or native bluegrass. The pasture should be divided into fields and grazing rotated from field to field. Grazing needs to be delayed until the soils are firm.

Some areas of these soils are suitable sites for stock water ponds. In many places small, wet potholes and depressions are in these soils. If these areas have not been drained, they generally are marshy and seasonally ponded. They are good nesting and breeding places for wildlife. Odd-shaped areas can be planted to provide food and cover for wildlife, and red clover and alsike

Figure 18.—**Wooded pasture on Dundas silt loam.**

clover are suitable legumes for planting. White spruce, white pine, and redcedar are suitable evergreens. Russian-olive is well adapted, and honeysuckle, lilac, and crabapple are some suitable shrubs.

These soils generally are not used for woodland, though many areas have unmanaged stands of hardwoods on them. Returns are more profitable if these soils are used for rotation crops. If it is desirable to use the areas for woodland, they should be protected from grazing and fire.

Capability unit IIIw–3

This unit consists of organic soils that are made up of partly decomposed vegetation and that are in low, wet areas. The peaty soils are more fibrous, less decayed, and less silty than the mucky soils. In all of the soils, fertility is low, and the moisture-supplying capacity is high. Wetness severely limits use.

If these soils are not adequately drained, they are used for pasture or wild hay or are left as habitat for wildlife. If drained, these soils generally are farmed intensively to corn and soybeans, to which they are well suited. They also are suited to potatoes, onions, and other garden vegetables. Small grains and mixtures of hay, such as alsike clover and timothy, can also be grown. Lodging is a serious problem if small grain is grown. Because of the hazard of frost, only varieties that mature early should be planted.

These soils should be drained only if enough water can be removed to make the soils suitable for crops. Open ditches generally are used to provide outlets for the drainage systems, and lateral lines leading to the ditches ordinarily are of tile. Tile should be placed at a depth of at least 4 feet to compensate for the settling and shrinking that takes place when these soils are drained. The shallow peat and muck decomposes rapidly under cultivation, and in these areas tile lines should be installed deep enough to remain effective after the soils have settled 18 to 24 inches. The drainage system needs controls that keep the soils from becoming too dry, because the risk of damage by fire to dry organic soils is serious.

Row crops can be grown continuously if these soils are adequately drained and if adequate fertilizer is applied. Legumes and grasses should be seeded occasionally to replenish the supply of organic matter. Seeding winter rye for a cover crop protects the soils from wind erosion and improves tilth. Adding manure, immediately after these soils are first drained, hastens decay of the organic matter to a form more readily available to crops.

Undrained areas in this unit are suitable for pasture if they are well managed. In such areas pasture can be established if the soil is worked when dry and then lime and fertilizer are applied and the areas are seeded to reed canarygrass. Reed canarygrass when well established forms a tough, dense sod that can support grazing animals and haying equipment, even though the soils are partly wet. Reed canarygrass is more productive and provides more palatable hay than wild marsh grass. All of these soils, and especially Peat and muck, shallow over loam, are good sites for stock water ponds (fig. 19).

Undrained areas of these soils provide good habitats for wildlife. Marshy areas can be developed for wildlife by use of level ditches or by installing structures that control the level of water. Wildlife areas must be protected from fire.

Soils in this unit are not suitable for trees. Many undrained areas, however, have poor stands of willow, tamarack, or brush on them.

Capability unit IIIw–4

This unit consists of medium-textured and moderately coarse textured, poorly drained and somewhat poorly drained soils of the Biscay, Duelm, and Watseka series. These soils have a sandy and gravelly substratum. They are on flats and in channels of the sandy outwash plains. Permeability is moderately rapid, but the water table is high and internal drainage therefore is poor. The supply of nutrients available to plants is moderate. These soils require drainage for successful yields of crops, but if they are adequately drained, they are likely to be slightly droughty during prolonged dry periods.

Figure 19.—**A stock water pond in Peat and muck, shallow over loam. The pond is properly fenced and marked, and the ramp approach is sanded. A raft at the right in the background provides a loafing site for ducks.**

If these soils are adequately drained, they are suitable for corn, soybeans, and small grains. They generally are too wet for alfalfa, but red clover, alsike clover, ladino clover, bromegrass, timothy, and similar legumes and grasses that tolerate wetness can be grown. Drainage can be improved by shallow surface ditches or grassed waterways. Tile drainage generally is not suitable, because these soils are shallow to sand and gravel.

Row crops can be grown continuously on these soils if adequate drainage is provided and the soils are otherwise well managed. These soils generally occur in odd-shaped channels, however, and generally are farmed the same as the surrounding Estherville soils, which are in capability unit IIIs–2.

Much of the acreage in this capability unit is pastured or used for wild hay. The areas generally are wet. They could be improved by working when dry and then applying fertilizer and seeding the areas to reed canarygrass or other grasses that tolerate wetness. Delay grazing until the soil is firm.

The vegetation on undrained areas of these soils generally is marsh grasses and a few willows, and it provides good cover for wildlife. Odd-shaped areas can be improved for wildlife by planting suitable evergreens, shrubs, legumes, and grasses to provide food and cover. These soils generally are not used for woodland.

Capability unit IIIs–1

This unit consists of somewhat excessively drained, nearly level sandy loams and loamy sands of the Hubbard and Rasset series. These soils are underlain by sand within a depth of 24 inches. The sandy substratum of the Rasset soils contains thin and variable layers of finer textured material. In all of these soils, permeability is moderately rapid and the moisture-supplying capacity is low. These soils are droughty and are subject to erosion and in places are moderately eroded. Fertility is moderate, but crops on these soils respond well if fertilizer is added. These soils warm up early in spring and are easy to till. Because they are shallow to sand, only 3 to 6 inches of water is available for plants in the upper 5 feet of these soils.

If rainfall is adequate throughout the growing season and if fertilizer is added and other good management is used, soils in this unit are suitable for all crops grown in the county. Crops on these soils respond well to irrigation. Using a suitable cropping system, stubble mulching, keeping the surface rough between crops, or growing cover crops and returning all crop residues to the soils reduces erosion and increases the supply of moisture. Plow in spring and keep tillage to a minimum. Wind stripcropping used with a cropping system that includes grass-legume meadow 1 year in 4 effectively controls erosion if sufficient crop residues are left on the surface.

The moderately eroded soils in this unit are low in nitrogen and in content of organic matter. They can be improved by applying large amounts of manure and growing legumes and grasses in the cropping system.

On these soils grazing the second year of meadow in the cropping system is better than maintaining permanent pasture. Permanent pasture is productive in spring and early in summer, but it dries up or does not grow at all in the hot summer months. More forage is produced on pasture of tall grass, such as bromegrass and alfalfa, than on pasture of permanent bluegrass. Permanent pasture of tall grass should be divided into fields and grazing rotated from field to field.

Cover for wildlife generally is lacking on soils in this unit. Clover and birdsfoot trefoil can be planted to provide food for deer and nesting cover for pheasant. Around sand pits and in odd-shaped areas evergreens, shrubs, legumes, and grasses that resist drought are preferred for planting.

These soils generally are not wooded, but they are well suited to evergreens.

Capability unit IIIs–2

In this unit are shallow, nearly level, somewhat excessively drained sandy loams and loams of the Estherville series. The gravel and sand that underlies these soils is coarser textured and more restrictive to root growth than that of soils in capability unit IIIs–1. Depth that roots can penetrate generally is no more than 24 inches.

These soils have low moisture-supplying capacity. They are droughty and are subject to wind erosion. Permeability is moderately rapid, and fertility is moderate to moderately low. These soils warm up early in spring and are easy to till. Crops on them respond well if fertilizer is applied. Because they are shallow to gravel and sand, only 3 to 6 inches of water is available for plants in the upper 5 feet of these soils.

If adequate moisture is available throughout the growing season, and if fertilizer is applied and other good management is used, these soils are suitable for all crops grown in the county and yields are good. Crops on these soils respond well to irrigation. In winter a protective cover of stubble or grass is needed for control of wind erosion. Returning all crop residues improves fertility and the supply of moisture and reduces erosion. Plow in spring and keep all tillage to a minimum.

A cropping system that includes legume-grass meadow 1 year in 4 is suitable. Wind stripcropping used with such a cropping system effectively controls erosion if sufficient crop residues are left on the surface.

Grazing the second year of meadow in the cropping system is better than maintaining permanent pasture on these soils. Pasture on these soils is productive early in the season but dries up or does not grow at all during the hot summer months. More forage is produced on pasture consisting of tall grasses, such as bromegrass and alfalfa, than on permanent bluegrass pasture. Permanent pasture consisting of tall grasses should be divided into fields, and the grazing rotated from field to field.

Cover for wildlife generally is lacking on most soils in this unit. Clover and birdsfoot trefoil can be planted to provide food for deer and nesting cover for pheasants. Around gravel pits and in odd-shaped areas, evergreens, shrubs, legumes, and grasses that resist drought are preferable for planting.

These soils generally are not wooded, but they are well suited to evergreens.

Capability unit IIIs–3

This unit consists of somewhat excessively drained, nearly level and gently sloping Braham and Anoka loamy fine sands and fine sands. These soils are underlain by

sand within a depth of 24 inches. The underlying material is variable and loamy and is within a depth of 42 inches.

In these soils the moisture-supplying capacity, fertility, and content of organic matter are low. Permeability is moderately rapid. In places the water table is fairly high, and in these areas the moisture-supplying capacity is better than in the other areas. These soils warm up early in spring and are easy to till, but they are droughty and are easily eroded by wind. Crops on them respond well if fertilizer is added. Only 3 to 6 inches of water that plants can use is held in the upper 5 feet of these soils.

These soils are better suited to small grains and to such crops as soybeans that are resistant to drought than they are to other crops. They are also well suited to melons. Corn can be grown if moisture is adequate throughout the growing season. Practices are needed that maintain fertility and the content of organic matter, and other good management as well. Crops on these soils respond to irrigation. Using a suitable cropping system, stubble mulching, keeping the surface rough between crops or in cover crops, and returning all crop residues to the soils are ways of reducing erosion and improving the supply of moisture. Plowing in spring and keeping tillage to a minimum are desirable.

A cropping system that includes legume-grass meadow 1 or 2 years in 5 is suitable. Wind stripcropping used with such a cropping system effectively controls erosion if sufficient crop residue is left on the surface.

The moderately eroded soils are low in nitrogen and content of organic matter. They can be improved if large amounts of manure are applied and legumes and grasses are grown in the cropping system.

Grazing the second year of meadow in the cropping system is better than maintaining permanent pasture on these soils. Permanent pasture is productive in spring and early in summer, but it dries up or does not grow at all in the hot summer months. More forage is produced on pasture made up of bromegrass and alfalfa than on permanent bluegrass pasture. Permanent pasture consisting of tall grasses should be divided into fields, and the grazing rotated from field to field.

Cover for wildlife generally is lacking on soils in this unit. Clover and birdsfoot trefoil can be planted to provide food for deer and nesting cover for pheasants. Around sand pits and in odd-shaped areas evergreens, shrubs, legumes, and grasses that resist drought can be planted. These soils are well suited to evergreens.

Capability unit IVe-1

This unit consists of deep, well-drained, sloping and moderately steep, medium-textured and moderately fine textured soils of the Hayden, Lester, and Storden series. Areas that have slopes of 6 to 12 percent are severely eroded, and some other areas that have slopes of 12 to 18 percent are moderately eroded. Areas mostly in pasture or woods are only slightly eroded.

In all these soils permeability and fertility are moderate, the moisture-supplying capacity is moderately high, and the content of organic matter is medium to low. Runoff is rapid, and these soils erode readily if left unprotected. The eroded soils generally are in poor tilth.

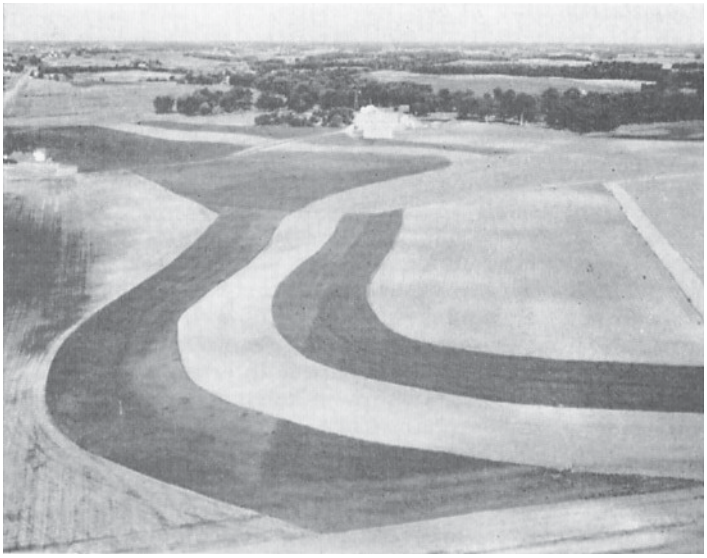

***Figure 20.*—Contour stripcropping on Lester soils.**

These soils are suited only to occasional cultivation, and corn must not be grown on them unless erosion is controlled. Alfalfa can be grown, and yields are good.

Contour stripcropping controls erosion more effectively on these soils than other practices (fig. 20). A satisfactory cropping system, if this practice is used, is alternate strips of alfalfa-bromegrass meadow 3 years in 5. If contour farming only is used, row crops should not be grown. A satisfactory system, if contour farming is used, is 1 year of small grain and 2 or 3 years of alfalfa-bromegrass meadow. Slopes generally are too steep for terraces to be used on these soils.

In many places slopes are short and irregular and contour stripcropping or contour farming is impractical. In these places it is difficult to protect the soils from erosion, and row crops should not be grown. Farming should be across the slope, and the cropping system should include meadow 3 years in 5.

Wherever they are needed, waterways should be established and maintained. Gullies should be shaped and seeded to grass for use as waterways. In some places engineering structures are needed to stabilize gullies enough for grass to grow in them. In severely eroded areas large amounts of fertilizer and manure are needed for improving tilth and fertility.

If fertilizer is applied and if these soils are otherwise well managed, they provide good permanent pasture. Many pastures now produce poor forage because they are partly wooded or are brushy. More forage is produced on pasture made up of tall grasses, or of a mixture of alfalfa and bromegrass, than on native bluegrass. Grazing must be controlled to prevent erosion.

Odd-shaped areas of these soils can be planted to trees and shrubs and seeded to a mixture of legumes and grasses to provide cover and food for wildlife.

Many areas of these soils are partly wooded, but they need protection from grazing and fire. All soils in this unit are well suited to pine trees.

Capability unit IVe–2

This unit consists of somewhat excessively drained, sloping sandy loams and loamy sands of the Hubbard and Rasset series. Some of these soils are moderately eroded. All of the soils are underlain by sand within a depth of 24 inches, and the sandy substratum of the Rasset soils contains thin and variable layers of finer textured material.

In all of these soils, the moisture-supplying capacity is low, fertility is moderate, and permeability is moderately rapid. These soils warm up early in spring and are easy to till. Crops on them respond well if fertilizer is applied. Use is severely limited, however, because the soils are droughty and are subject to erosion.

If the supply of moisture is adequate, these soils are fairly good for crops. Corn, oats, hay, and pasture plants are the chief crops grown. Because these soils are droughty, varieties that mature early should be planted.

Practices are needed that protect these soils from erosion, and the cropping system used depends on the kind of practice. If these soils are farmed on the contour, a suitable cropping system includes meadow 2 years in 6. Contour stripcropping, with alternate strips in alfalfa-bromegrass meadow 2 years in 4, reduces runoff and thus effectively controls erosion. If terraces are used, a satisfactory system is 2 years of grass-legume meadow in 5. If no practices are applied because slopes are uneven or irregular, a suitable cropping system includes meadow 2 years in 5.

Before terraces are constructed, the underlying substratum must be checked. Level terraces can generally be used, and in places on long slopes diversion ditches can be used. Gullies in these soils should be shaped and seeded to grass for use as waterways.

Returning all crop residues to these soils improves fertility, increases the supply of moisture, and protects the soils from erosion. Plowing under green-manure crops and crop residues in spring, keeping a cover of vegetation on these soils and keeping tillage to a minimum, and plow-planting row crops are other practices that help control erosion.

The moderately eroded soils are low in nitrogen and in content of organic matter. They can be improved if large amounts of manure are applied and if legumes and grasses are grown in the cropping system.

Because soils in this unit are droughty, they are poorly suited to permanent pasture. On these soils more forage is produced from the second year of meadow in the cropping system than from permanent pasture. Pasture consisting of alfalfa and bromegrass is more productive and resistant to drought than native bluegrass pasture.

Cover for wildlife generally is lacking on many soils in this unit. Planting a mixture of alfalfa-bromegrass in odd-shaped areas provides good nesting cover if the areas are protected from fire and grazing. Colorado spruce, white spruce, and redcedar are suitable evergreens for planting. Russian-olive is well adapted, and Caragana is a suitable shrub. All of these soils are well suited to evergreens.

Capability unit IVe–3

This unit consists mostly of shallow, somewhat excessively drained, sloping sandy loams and loams of the Burnsville, Emmert, Estherville, Hayden, Lester, and Milaca series. Some of these soils are moderately eroded. Most of these soils are underlain by a layer of gravel and sand that is coarser textured than that of soils in capability unit IVe–2 and is more restrictive to root growth. The Hayden, Lester, and Milaca soils, however, are deep and loamy. In many places large stones and boulders occur in areas of all of the soils in this unit.

All of these soils have low moisture-supplying capacity and moderate to moderately low fertility. Permeability is moderately rapid. These soils warm up early in spring, and except in stony areas, they are easy to till. Crops on them respond well if fertilizer is applied. Use is severely restricted, however, because these soils are droughty and are subject to erosion.

Soils in this unit can be cultivated occasionally, but practices that prevent further erosion are needed. Crops that mature early and winter grains are best adapted.

These soils must be plowed in spring, for if plowed in fall, they are exposed to erosion throughout the winter. Returning all crop residues improves fertility and the supply of moisture and reduces erosion. Wheel-track planting or plow-planting of row crops also helps to control erosion. Keeping a cover of vegetation on these soils and holding tillage to a minimum are ways of conserving moisture and soil. In many places slopes are too uneven or irregular for growing row crops and practices cannot be applied to protect the soils from erosion.

If contour farming is used, a suitable cropping system includes meadow 3 years in 5. Contour stripcropping effectively controls erosion, and a satisfactory system if this practice is used, consists of alternate strips of grass-legume meadow 2 years in 4. Terraces generally are not suitable for these soils, because they are shallow to gravel and sand. In places on long slopes, diversion ditches can be used.

Waterways should be established and maintained. The sides of waterways and gullies should be shaped, seeded to grass, and then kept in vegetation. In some places engineering structures are needed to stabilize gullies enough for grass to grow in them.

The moderately eroded soils are low in nitrogen and in content of organic matter. They can be improved by applying large amounts of manure and growing legumes and grasses in the cropping system.

Pasture on these soils is fairly good early in spring, but the soils are droughty, and little forage is produced in the dry summer months. More forage is produced from the second year of meadow in the cropping system than from permanent pasture. Pasture of alfalfa and bromegrass is more drought resistant and more productive than pasture of native bluegrass. Many areas of Burnsville soils and of soils in the Emmert-Milaca complex are poor for pasture because they are partly wooded or are brushy. Overgrazing must be avoided to prevent erosion and to maintain the sod.

Gravel pits and odd-shaped areas of these soils can be developed for wildlife. Trees, shrubs, legumes, and grasses that resist drought can be planted for food and

cover. Colorado spruce, white spruce, and redcedar are suitable evergreens. Russian-olive is well adapted, and Caragana is a suitable shrub.

These soils are well suited to trees, and especially to evergreens. All woodland must be protected from grazing and fire.

Capability unit IVs–1

In this unit are deep, excessively drained, nearly level and gently sloping loamy sands and fine sands of the Chelsea and Hubbard series. These soils have rapid permeability and very low moisture-supplying capacity. Fertility is low, but if moisture is adequate, crops on these soils respond well to fertilizer. These soils warm up early in spring and are easy to cultivate, but they are droughty and the hazard of wind erosion is severe. Because they are porous, no more than 3 inches of water that plants can use is held in the upper 5 feet of these soils.

Soils in this unit are better suited to winter grains, melons, and crops that mature early than to other crops. Yields of corn and soybeans generally are poor. If these soils are irrigated and are otherwise well managed, they are suitable for potatoes and other truck crops. In places these soils are near streams, which are a good source of water for irrigation. In other places water can be obtained through sand points driven to a water-bearing stratum.

Drought and wind erosion are serious problems on these soils; a cropping system that provides cover the year round is needed. Returning all crop residues and available manure to the soils helps to control wind erosion and increases the supply of moisture. Plowing should be done in spring. Tillage must be kept to a minimum. Wind stripcropping, stubble mulching, and growing of shelterbelts of pine all help to control wind erosion.

For control of erosion, the cropping system used depends on the practice. In the nearly level areas, wind stripcropping and a cropping system that includes legume-grass meadow 1 or 2 years in 6 is satisfactory. Sufficient crop residues must be left on the surface. If contour farming is used, a suitable cropping system consists of grass-legume meadow 2 years in 5. Contour stripcropping, with the alternate strips in grass-legume meadow 2 years in 4, also is an effective system. Terraces generally are not suitable for these soils, but wherever needed, waterways should be established and maintained.

Because these soils are droughty, it is difficult to keep a good sod on them, and they are therefore poor for permanent pasture. On these soils grazing the second year of meadow in the cropping system is better than maintaining permanent pasture. More forage is produced on pasture consisting of alfalfa and bromegrass than on pasture made up of native bluegrass because such plants are more resistant to drought. Many pastures on Chelsea soils are wooded or are brushy. Yields are more favorable if these soils are used for rotation crops after a brushy pasture has been cleared.

In areas where winter cover is lacking, odd-shaped areas can be improved for wildlife by planting evergreens, shrubs, legumes, and grasses that resist drought. In areas where winter cover is adequate, corn and small grain should be left for pheasants, or these grains should be planted for them.

All soils in this unit are well suited to evergreens. Areas in woodland must be protected from grazing and fire.

Capability unit IVs–2

This unit consists of very shallow, excessively drained, nearly level and gently sloping loamy sands and gravelly sandy loams of the Hubbard and Salida series. Depth to loose gravel and sand generally is less than 12 inches. The moisture-supplying capacity and fertility are low. Permeability is rapid to very rapid.

These soils warm up early in spring. They are generally easy to work, but stones or boulders interfere with tillage on soils in the Salida complex. All soils in this unit are porous; less than 3 inches of water that plants can use is held in the upper 5 feet. It is difficult for roots to penetrate to a depth of more than 12 to 18 inches. These soils are droughty and blow readily.

These soils are marginal for most crops. Rye, wheat, and other winter small grains are best suited. Moisture generally is not sufficient for even poor yields of corn or soybeans. It is difficult to get a satisfactory stand of legumes.

Any cropping system used on these soils should provide year-round cover. Returning all available manure and crop residues to the soils helps improve the supply of moisture and controls erosion. All tillage should be done in spring. Wind stripcropping, stubble mulching, and planting shelterbelts of pine help to control wind erosion. A cropping system that includes hay 1 year in 3 can be used, but yields generally are low. If wind stripcropping is used, a suitable cropping system for control of erosion is grass-legume meadow 1 year in 4. If contour stripcropping is used, a satisfactory system is meadow 2 years in 4. These soils are shallow to gravel, and terracing is not suitable. Gullies should be shaped and seeded to grass for use as waterways.

Because it is difficult to maintain a good sod on these soils, they generally are not suitable for permanent pasture. Pastures on some soils of the Salida complex are wooded or are brushy. Yields are more favorable if these brushy areas are cleared, are put into a suitable cropping system, and are not pastured until the second year of meadow. More forage is produced on a pasture consisting of alfalfa and bromegrass than on pasture of native bluegrass, because such plants are more resistant to drought than the bluegrass. Grazing must be controlled to maintain the sod and control erosion.

The soils in this unit can be improved for wildlife by planting redcedar, red pine, and other trees and shrubs that resist drought.

These soils are suitable for evergreens. All areas used as woodland must be protected from grazing and fire.

Capability unit IVs–3

This unit consists of somewhat excessively drained, sloping Braham and Anoka loamy fine sands and fine sands. Some areas are eroded. These soils are shallow to sand, but the underlying material is variable and

loamy and helps somewhat to retain moisture. Fertility, moisture-supplying capacity, and content of organic matter are low. Permeability is moderately rapid.

These soils warm up early in spring, are easy to cultivate, and respond well if fertilizer is applied. Only 4 or 5 inches of water that plants can use is held in the upper 5 feet. These soils are sandy and droughty and erode readily.

These soils are better suited to crops that resist drought and mature early than to other crops. Winter grains, melons, and alfalfa are suited. Yields of corn generally are low because moisture is lacking.

Practices are needed that protect these soils from erosion, and the cropping system used depends on the practice. If contour farming is used, a cropping system that includes meadow 3 years in 6 is suitable. Contour stripcropping, with alternate strips in meadow 2 years in 4, effectively controls erosion. If terracing is used, a suitable cropping system includes meadow 2 years in 5. Before terracing is done, the underlying substratum should be checked. Diversion ditches can be used to protect some of the longer slopes from erosion. Gullies can be shaped and seeded for use as waterways. If such practices are not feasible because of irregular slopes, a satisfactory system is 2 or 3 years of meadow in 5 years.

Returning all crop residues to these soils improves fertility, increases the supply of moisture, and reduces erosion. Plowing under green-manure crops and crop residues in spring, keeping the soils under a cover of vegetation and holding tillage to a minimum, and plow-planting of row crops are other practices that help to control erosion.

The moderately eroded soils are low in nitrogen and in content of organic matter. They can be improved by applying large amounts of manure and growing legumes and grasses in the cropping system.

These soils are droughty and are not suited to permanent pasture. More forage is produced if a suitable cropping system is used and the second year of meadow is pastured. Pasture of alfalfa and bromegrass is more resistant to drought than pasture of native bluegrass and also is more productive.

Cover for wildlife generally is lacking on soils in this unit. Planting a mixture of alfalfa and bromegrass in odd-shaped areas provides good nesting cover if the areas are protected from fire and grazing. Colorado spruce, white spruce, and redcedar are suitable evergreens to plant. Russian-olive is well adapted, and Caragana is a suitable shrub. These soils are well suited to evergreens.

Capability unit Vw–1

This unit consists of one Peat and muck soil, which is underlain by sand within a depth of 42 inches. Most areas of this soil are in wet depressions in sandy outwash plains. Fertility is low, and the hazard of frost is more severe than on soils in higher areas. Fire is also a serious hazard, because if the peaty material is burned, the underlying sand generally is sterile.

This soil generally is not used for crops, because it is too wet, and generally it is impractical to drain it. Most areas are used for wild hay or pasture.

Tile is not suitable for drainage, but shallow surface ditches can be used. Pasture on this soil can be improved by working the soil when dry and then adding fertilizer and seeding the areas to reed canarygrass. Topdressing with fertilizer improves the quality and palatability of the grass. Reed canarygrass, when well established, forms a tough, dense sod that supports light haying equipment or grazing cattle even when the soils are somewhat wet. Reed canarygrass hay is of better quality and is more palatable than hay from marsh grass.

Most soils in this unit provide good cover for wildlife. Many of the areas can be improved by constructing shallow pits that provide open water for ducks and other water birds. The areas also should be protected from fire. These soils are too wet for use as woodland.

Capability unit VIe–1

This unit consists of deep, well-drained, moderately steep and steep, medium-textured and moderately fine textured soils of the Hayden, Lester, and Storden series. Permeability and fertility are moderate. The content of organic matter is medium to low. Runoff is rapid, and the moisture-supplying capacity is moderately high. All soils that have slopes of 12 to 18 percent have been used for cultivated crops and are severely eroded. Some soils that have slopes of 18 to 25 percent have been cropped, and these are moderately eroded.

These soils are not suitable for crops, because of the severe hazard of erosion. They are suited to hay or pasture or to use as woodland or wildlife areas.

Areas now in permanent pasture or woods should never be cleared, and areas now in crops ought to be put into permanent vegetation. Most of these soils have free lime carbonates within a depth of 36 inches, and they are therefore well suited to alfalfa and other legumes. Pasture consisting of alfalfa and bromegrass is more productive than native bluegrass. A good cover of vegetation is needed on all cleared areas. Grazing must be controlled to prevent further erosion.

Pasture or hay meadows can be improved by renovating and reseeding them. The old sod can be killed by disking or digging and then left on the surface to protect the soils from erosion until the new seeding becomes established and provides cover. Oats can be used as a nurse crop when pasture needs renovating. The oats can be clipped, pastured, or harvested for grain. If plowing must be done, it should be done in spring. Gullies should be shaped and seeded to grass for use as waterways. In some gullies, engineering structures may be required to stabilize the banks enough to let grass get started (fig. 21).

Areas of these soils can be planted to provide shelter and food for wildlife. White spruce, red pine, white pine, redcedar, Russian-olive, honeysuckle, lilac, Caragana, legumes, and grasses are suitable for planting. In woodlots leave two den trees per acre for squirrels.

Trees can be planted to improve woodland or to reestablish trees on cropland and in pasture. All woodland must be protected from grazing and fire.

Capability unit VIe–2

This unit consists of shallow, somewhat excessively drained, sloping and moderately steep sandy loams and loams of the Burnsville, Emmert, Estherville, Hayden, Lester, and Milaca series. Most of these soils are under-

Figure 21.—**This deep gully in a moderately steep Hayden loam must be stabilized before it is seeded to grass.**

lain by sand or gravel within a depth of 24 inches. In the Burnsville-Hayden complex, Emmert-Milaca complex, and Lester-Estherville complex, however, the soils are shallow over underlying material or are deep loams. In many places large stones and boulders are on the surface and throughout the profile.

In all of these soils permeability is moderately rapid and the moisture-supplying capacity is low. Fertility is moderate to low. These soils are droughty, and the hazard of erosion is severe. All soils that have slopes of 6 to 12 percent have been used for cultivated crops and are severely eroded. In places some areas of soils that have slopes of 12 to 18 percent have been cropped, and these areas are moderately eroded.

These soils are too droughty and too erodible for crops. They can be used for pasture or hay or as woodland or wildlife areas. Areas now in crops ought to be put into permanent vegetation.

If soils in this unit are used for pasture or hay, good management is needed to maintain the sod. Pasture of alfalfa and bromegrass is more resistant to drought and provides more forage than pasture of native bluegrass, which does not grow during hot summer months.

Pasture can be renovated when necessary by plowing the area in spring, and then applying fertilizer and seeding to oats and suitable grasses and legumes. The oats can be clipped or pastured when they are ready to head out.

Gullies in these soils should be shaped and seeded to grass for use as waterways. In some of the gullies, engineering structures may be needed to stabilize the sides enough to get the grass started.

Areas of these soils can be developed to provide food and shelter for wildlife. White pine, red pine, redcedar, Russian-olive, honeysuckle, lilac, Caragana, legumes, and grasses are suitable for planting. In woodland leave two den trees per acre for squirrels.

Trees can be planted to improve woodland or to reestablish timber on cropland or in pasture.

Capability unit VIw–1

Soils in this unit are along streams on bottom lands that are flooded frequently. They consist of Alluvial land and of soils of the Comfrey series. Most of these soils are silty and are poorly drained or very poorly drained. Some are in old stream channels and are seasonally ponded or are very wet the year round. The soils on slightly elevated ridges and mounds between the old channels are more sandy and are better drained. On all these soils the hazard of flooding is high and severely restricts use.

These soils are not suitable for crops, because most areas are too wet and are subject to further flooding. They are suitable for pasture or woodland and for use as wildlife areas.

Row crops can be grown occasionally on drier areas of these soils. At present it is too costly to provide the engineering and flood-control structures that are needed to protect most areas and to make them suitable for crops. Drainage of the wet soils is not feasible, so long as the hazard of flooding exists.

The better drained soils in this unit provide good pasture if they are cleared and well managed. Varieties of grasses and legumes that tolerate flooding can be seeded. Renovating and reseeding are especially needed if the sod has been covered by infertile material deposited by floods. If oats are used as a companion crop in seeding a pasture, the oats can be clipped or pastured before they head out. If left longer, they are likely to lodge and kill the new grass seedlings.

Pasture on poorly drained areas is difficult to renovate because the soils are wet throughout the year. Reed canarygrass or other plants that tolerate both flooding and continued wetness can be seeded. If reed canarygrass is seeded in fall, it must be seeded after the soil is frozen. It can also be seeded on frozen soil in spring. Avoid grazing early in spring, or following a flood, to prevent trampling of the sod. In places where a stream makes a sharp turn, the streambank needs to be stabilized to keep the stream from cutting into areas in crops or pasture.

On most areas of these soils wildlife is abundant. The marsh grasses, cattails, and wet sedges provide excellent cover and nesting places. In developing shelter for wildlife, conifers, shrubs, sedges, and grasses that tolerate continued wetness and frequent flooding are preferred for planting. All areas need protection from fire.

Soils in this unit are too wet for trees, but many areas are in pasture that is brushy or is wooded.

Capability unit VIs–1

This unit consists of deep, excessively drained, sloping loamy sands and fine sands of the Chelsea and Hubbard series, some of which are moderately eroded. Permeability of these soils is rapid, moisture-supplying capacity is very low, and fertility is low or very low. All of these soils are droughty and hold less than 3 inches of water that plants can use in the upper 5 feet. Because these soils are sloping and sandy, the hazard of further erosion is severe.

These soils are suitable for hay and pasture and for use as woodland and wildlife areas. They are too

droughty and erodible for crops. Areas now in crops ought to be put into permanent vegetation.

If these soils are used for pasture or hay, good management is needed to maintain the sod. Pasture of alfalfa and bromegrass is more resistant to drought and provides more forage than pasture of native bluegrass, which does not grow at all during the hot summer months.

Pasture can be renovated when necessary by plowing the area in spring and then applying fertilizer and seeding to oats and suitable grasses and legumes. The oats need to be pastured or clipped when they are ready to head.

Gullies in these soils should be shaped and seeded to grass for use as waterways. Some gullies may require engineering structures that stabilize them enough to allow grass to grow.

Areas of these soils can be developed to provide food and shelter for wildlife. White pine, red pine, redcedar, Russian-olive, honeysuckle, lilac, Caragana, legumes, and grasses are suitable for planting. In woodland leave two den trees per acre for squirrels.

Trees can be planted to improve woodland or to reestablish trees on cropland or in pasture.

Capability unit VIIe-1

This unit consists of deep, well-drained, medium-textured and moderately fine textured soils of the Hayden and Lester series, some of which are severely eroded. These soils are on moderately steep and very steep hills and ridges. Permeability is moderate. The moisture-supplying capacity is moderately high, but because runoff is very rapid, the amount of water that enters the soil is much reduced. The hazard of further erosion is severe.

These soils are not suited to cultivated crops, and areas now in crops ought to be put into permanent vegetation. If these soils are used for pasture or hay, a good cover of plants should be maintained for control of erosion. Also grazing must be limited and other good management used (fig. 22). These soils are well suited to trees and to use as wildlife areas. Areas now in permanent pasture or woods should never be cleared.

Figure 22.—**Areas of Hayden soils that are severely eroded as the result of overgrazing.**

Gullies in these soils should be shaped and seeded to grass for use as waterways. Some of the gullies may require engineering structures that stabilize them enough to allow grass to grow.

White spruce, red pine, white pine, redcedar, Russian-olive, honeysuckle, lilac, Caragana, legumes, and grasses can be planted to provide food and shelter for wildlife. In woodlots leave two den trees per acre for squirrels.

These soils are well suited to trees. Trees can be planted to improve woodland or to reforest pastured areas. All wooded areas must be protected from grazing and fire.

Capability unit VIIe-2

In this unit are shallow, moderately steep to very steep, somewhat excessively drained sandy loams and loams of the Burnsville, Emmert, Estherville, Hayden, and Milaca series. Some of these soils are severely eroded. Most of these soils are underlain by gravel and sand within a depth of 24 inches. The Burnsville-Hayden complex and the Emmert-Milaca complex, however, consist of areas of shallow soils intermingled with deep loams and are stony and cobbly in many places. All of the soils have moderately rapid permeability and low moisture-supplying capacity. Fertility is low. Droughtiness and the severe erosion hazard are problems.

These soils are too droughty for row crops. They can be used for pasture or hay, but it is difficult to maintain a good cover of vegetation. Many areas have only a sparse growth of vegetation on them. If these soils are pastured, grazing must be controlled to prevent overgrazing. It is best to use these soils as woodland or wildlife areas.

Gullies in these soils should be shaped and seeded to grass for use as waterways. Some of the gullies may require engineering structures that stabilize them enough to allow grass to grow.

Conifers, shrubs, grasses, and legumes suitable for droughty, shallow soils can be planted to provide cover and food for wildlife.

Soils in this unit generally are well suited to pine trees. All wooded areas must be protected from grazing and fire.

Capability unit VIIs-1

In this unit are deep, very droughty, moderately steep to very steep, sandy soils of the Anoka, Braham, Chelsea, and Hubbard series and nearly level to gently sloping Beach materials, sandy. All of these soils are rapidly permeable. The moisture-supplying capacity and fertility are low. Drought and the hazard of erosion severely limit use.

These soils are not suitable for crops. Yields of all row crops are poor. Pastured areas generally provide poor forage, and it is difficult to keep a permanent cover of sod on the areas. It is best to use these soils for woodland or as wildlife areas.

If these soils are used for pasture or hay, keep a good cover of vegetation on them. Suitable plants are bromegrass, beachgrass, or other grasses that resist drought. Pasture of alfalfa and bromegrass is more resistant to

drought than pasture of native bluegrass and provides better forage. Grazing should be carefully controlled.

Gullies in these soils should be shaped and seeded to grass for use as waterways. Some of the gullies may require engineering structures that stabilize them enough to allow grass to grow.

These soils can be developed for wildlife areas by planting evergreens, shrubs, legumes, and grasses that resist drought.

Most of these soils are suitable for pine trees. All wooded areas must be protected from grazing and fire. Trees can be planted to improve present woodland and to reforest cropland or areas now in pasture or idle.

Capability unit VIIs–2

Soils in this unit are droughty, coarse textured, and sloping to very steep. These soils are in the Hubbard and Salida series. They are underlain by gravel and sand within a depth of 12 inches. The moisture-supplying capacity and fertility are low. The surface layer generally is gravelly and in some places contains large stones and boulders. Drought and the hazard of erosion seriously limit use.

These soils are too droughty for crops, and it is difficult to maintain a good cover of vegetation on them if they are used for pasture or hay. In many areas vegetation is sparse. If these soils are pastured, overgrazing must be prevented. The areas are best used for woodland or to provide food and shelter for wildlife.

Gullies in areas of these soils should be shaped and seeded to grass for use as waterways. Some of the gullies may require engineering structures that stabilize them enough to allow grass to grow.

Conifers, shrubs, grasses, and legumes are suitable for droughty and shallow soils such as these; they can be planted to provide shelter for wildlife.

It is best to keep a cover of trees on these soils, and pines generally are well suited. All wooded areas must be protected from grazing and fire.

Capability unit VIIIw–1

Marsh makes up this capability unit. This land type is along the edges of some lakes, shallow basins, and ponds. The water level fluctuates, depending on the season, and some areas are dry during years when rainfall is less than normal. The vegetation consists of cattails, rushes, sedges, willows, and other plants that tolerate wetness. Because the areas are wet, the soil material has not been identified.

Marsh is too wet for crops, pasture, or trees. In places during prolonged dry spells, the edges of the marsh can be cut for wild hay. Special surveys are needed to determine if it is feasible to provide artificial drainage. If drained, areas of Marsh generally require management similar to that for soils in capability units IIIw–1 and IIIw–3.

Areas of Marsh provide good habitats for waterfowl, muskrat, mink, and game from the upland, which find food, cover, and nesting places in marshy areas. The areas can be improved for wildlife by providing level ditches for controlling the level of the water. Areas used for wildlife must be protected from fire. In places trapping of muskrats and the sale of hunting rights is done commercially.

Predicted Yields

In table 2 are predicted long term average acre yields for the principal crops grown in Wright County under two levels of management. These yields are based on records and observations of representatives of the Soil Conservation Service, the Extension Service, and the University of Minnesota. They are also based on interviews with farmers.

Yields are not given for crops that are not considered suitable for a particular soil. The major crops can be grown on such soils, but because the soils are droughty, steep, severely eroded, poorly drained, or susceptible to flooding, the crops are not likely to be successful. For soils on which adequate drainage makes a considerable difference in suitability for crops, yields are given with and without adequate drainage.

It is assumed that rotation pasture consists of a mixture of suitable legumes and grasses. Permanent pasture, under average management, consists principally of native grass. Under improved management, in which permanent pasture is renovated at intervals, a mixture of suitable grasses and legumes is the principal cover.

The yield figures represent an average to be expected over a period of 10 years. They do not take into account abnormal crop seasons or past management on a particular farm. Considered in making the estimates were the prevailing climate, characteristics of the soils, and the influence of different kinds of management on the soils. The figures are useful chiefly in judging the increases that can be expected from improved management and from draining the soils.

In columns A are yields to be expected under average management. The management used to obtain these average yields consists of using a cropping system that is made up mainly of cultivated crops, and on many farms corn is alternated with oats or soybeans. Where corn is planted, all available manure and starter fertilizer is applied. Little or no fertilizer is applied to small grains or to hay meadows. A legume meadow is grown 2 years in 6. The number of corn plants per acre ranges from 14,000 to 16,000, and three cuttings are made of alfalfa hay each year. Few or no practices are used for control of erosion.

Yields given in columns B are those expected under improved management. The requirements of good management vary according to the soils, but under this level of management, crops suited to the soils are grown in a suitable cropping system. Commercial fertilizers, lime, and manure are applied, proper tillage methods are used, and all organic material is returned to the soils. Also weeds, insects, and diseases are adequately controlled. The productivity and workability of the soils are maintained or improved, water is adequately controlled, and the soils, plant nutrients, and soil moisture are conserved. The number of corn plants per acre, under good management, ranges from 18,000 to 20,000, and three cuttings are made of alfalfa hay each year.

TABLE 2.—*Predicted average acre yields of principal crops under two levels of management*

[Yields in columns A are those expected under average management; those in columns B are expected under improved management, as described in the individual capability units. Absence of a figure indicates the crop ordinarily is not grown or the soil is not suited to it. Where separate yields are not given for each component of a soil complex or undifferentiated unit, they are expected to be the same]

Soil	Corn for grain		Corn for silage		Soybeans		Oats		Rotation hay [1]		Rotation pasture		Permanent pasture	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Cow-acre-days* [2]	*Cow-acre-days* [2]	*Cow-acre-days* [2]	*Cow-acre-days* [2]
Alluvial land													70	90
Beach materials, sandy														
Becker loam [3]	50	65	10	12	25	30	40	45	2.0	2.5	125	155	80	100
Biscay loam:														
Inadequately drained	50		10		15		25		1.5				80	90
Adequately drained	65	80	13	15	25	32	40	50	2.5	3.5	135	160		
Biscay loam, sandy subsoil variant:														
Inadequately drained	35		7		15		25						80	90
Adequately drained	50	60	10	12	20	25	35	45	1.5	2.0	110	135		
Blue Earth silt loam:														
Inadequately drained													40	70
Adequately drained	50	65	10	12	25	30	35	45	2.0	2.5	125	150		
Braham and Anoka fine sands, 2 to 6 percent slopes, moderately eroded	25	35	5	7	5	7	25	30	1.5	2.0	55	75	25	30
Braham and Anoka fine sands, 6 to 12 percent slopes, moderately eroded	15	25	4	6			15	20	1.0	1.2	45	65	20	25
Braham and Anoka fine sands, 12 to 25 percent slopes													20	25
Braham and Anoka loamy fine sands, 0 to 2 percent slopes	30	40	6	8	8	10	30	35	1.5	2.0	60	80	25	35
Braham and Anoka loamy fine sands, 2 to 6 percent slopes	30	40	6	8	7	9	30	35	1.5	2.0	60	80	25	35
Braham and Anoka loamy fine sands, 6 to 12 percent slopes	20	30	5	7			20	25	1.3	1.5	45	65	20	25
Burnsville soils, 0 to 6 percent slopes	35	45	7	9	8	10	30	40	1.5	2.0	75	90	30	40
Burnsville soils, 2 to 6 percent slopes, moderately eroded	25	35	5	7	6	8	25	30	1.2	1.5	75	90	30	40
Burnsville soils, 6 to 12 percent slopes	20	30	4	6			25	30	1.2	1.5	65	75	25	30
Burnsville soils, 6 to 12 percent slopes, moderately eroded	20	25	3	5			20	25	1.0	1.3	55	65	25	30
Burnsville soils, 6 to 12 percent slopes, severely eroded													20	25
Burnsville soils, 12 to 18 percent slopes													25	30
Burnsville soils, 12 to 25 percent slopes, severely eroded													20	26
Burnsville soils, 18 to 35 percent slopes													20	25
Burnsville-Hayden complex, 2 to 6 percent slopes:														
Burnsville part	30	40	6	8	7	9	25	35	1.5	2.0	75	90	30	40
Hayden part	55	65	11	13	20	25	45	55	3.0	3.5	150	180	50	90
Burnsville-Hayden complex, 2 to 6 percent slopes, moderately eroded:														
Burnsville part	25	35	5	7	6	8	25	30	1.2	1.5	75	90	30	40
Hayden part	50	60	10	12	18	22	40	50	2.5	3.0	150	180	55	90
Burnsville-Hayden complex, 6 to 12 percent slopes:														
Burnsville part	20	30	4	6			25	30	1.2	1.5	65	75	25	30
Hayden part	40	50	8	10	14	18	30	40	2.0	2.5	130	155	50	80
Burnsville-Hayden complex, 6 to 12 percent slopes, moderately eroded:														
Burnsville part	20	25	3	5			20	25	1.0	1.3	55	65	25	30
Hayden part	40	50	8	10			30	40	2.0	2.5	130	155	50	0
Burnsville-Hayden complex, 12 to 18 percent slopes:														
Burnsville part													25	30
Hayden part													45	65
Burnsville-Hayden complex, 18 to 35 percent slopes:														
Burnsville part													20	25
Hayden part													40	60

See footnotes at end of table.

TABLE 2.—*Predicted average acre yields of principal crops under two levels of management*—Continued

Soil	Corn for grain		Corn for silage		Soybeans		Oats		Rotation hay [1]		Rotation pasture		Permanent pasture	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Cow-acre-days* [2]	*Cow-acre-days* [2]	*Cow-acre-days* [2]	*Cow-acre-days* [2]
Canisteo silty clay loam:														
Inadequately drained	45	-----	8	-----	18	-----	40	-----	1.5	-----	-----	-----	85	100
Adequately drained	70	85	13	15	30	35	50	60	3.0	3.5	175	200	-----	-----
Chelsea fine sand, 2 to 6 percent slopes	20	30	4	6	6	8	25	30	1.0	1.5	30	50	20	25
Chelsea fine sand, 6 to 12 percent slopes	20	25	4	5	-----	-----	20	25	.4	.8	25	40	15	20
Chelsea fine sand, 12 to 18 percent slopes	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	15	20
Clayey basin land:														
Inadequately drained	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	40	80
Adequately drained	60	75	12	14	30	35	45	60	2.0	2.8	140	160	-----	-----
Comfrey silty clay loam	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	70	90
Comfrey silty clay loam, depressional	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	40	80
Cordova and Le Sueur silty clay loams:														
Cordova part—														
Inadequately drained	50	-----	9	-----	18	-----	45	-----	1.5	-----	-----	-----	80	100
Adequately drained	75	90	15	17	30	35	55	65	3.0	3.5	175	200	-----	-----
Le Sueur part	80	90	15	17	32	37	55	70	3.5	4.0	175	200	80	120
Cordova and Webster silty clay loams:														
Inadequately drained	50	-----	9	-----	18	-----	45	-----	1.5	-----	-----	-----	80	100
Adequately drained	75	90	15	17	30	35	55	65	3.0	3.5	175	200	-----	-----
Duelm and Watseka soils:														
Duelm part	40	50	8	10	15	20	35	40	1.7	2.0	100	120	30	65
Watseka part	40	45	8	9	14	16	35	40	1.5	2.0	85	110	40	55
Dundas silt loam:														
Inadequately drained	40	-----	8	-----	18	-----	40	-----	1.5	-----	-----	-----	80	100
Adequately drained	55	70	11	14	22	28	50	60	3.0	3.5	160	195	-----	-----
Dundas and Ames silt loams:														
Dundas part—														
Inadequately drained	40	-----	8	-----	18	-----	40	-----	1.5	-----	-----	-----	80	100
Adequately drained	55	70	11	14	22	28	50	60	3.0	3.5	160	195	-----	-----
Ames part—														
Inadequately drained	40	-----	8	-----	15	-----	35	-----	1.5	-----	-----	-----	80	100
Adequately drained	50	65	10	12	20	25	45	55	3.0	3.5	160	195	-----	-----
Emmert-Milaca complex, 2 to 6 percent slopes:														
Emmert part	30	40	6	8	6	8	25	35	1.5	2.0	75	90	40	50
Milaca part	50	60	10	12	20	25	40	50	2.5	3.0	150	180	60	90
Emmert-Milaca complex, 6 to 12 percent slopes:														
Emmert part	20	30	4	6	-----	-----	25	30	1.2	1.5	65	75	25	30
Milaca part	40	50	8	10	-----	-----	30	40	2.0	2.5	130	155	5	75
Emmert-Milaca complex, 12 to 18 percent slopes:														
Emmert part	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	20	25
Milaca part	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	50	70
Emmert-Milaca complex, 18 to 35 percent slopes:														
Emmert part	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	15	20
Milaca part	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	30	55
Estherville loam, 0 to 2 percent slopes	40	50	8	10	12	14	35	45	1.8	2.0	85	100	40	50
Estherville loam, 2 to 6 percent slopes	35	45	7	9	10	12	30	40	1.8	2.0	85	100	40	50
Estherville loam, 2 to 6 percent slopes, moderately eroded	30	40	6	8	8	10	25	35	1.5	2.0	75	90	30	40
Estherville loam, 6 to 12 percent slopes	25	35	5	7	6	8	25	30	1.2	1.5	65	75	30	40
Estherville loam, 6 to 12 percent slopes, moderately eroded	20	30	4	6	-----	-----	20	25	1.0	1.3	55	65	25	30
Estherville sandy loam, 0 to 2 percent slopes	35	45	7	9	10	12	30	35	1.5	2.0	75	90	30	40
Estherville sandy loam, 2 to 6 percent slopes	30	40	6	8	8	10	28	32	1.5	2.0	75	90	30	40
Estherville sandy loam, 2 to 6 percent slopes, moderately eroded	25	35	5	7	5	7	25	30	1.2	1.5	75	90	30	40
Estherville sandy loam, 6 to 12 percent slopes	20	30	4	6	-----	-----	25	30	1.2	1.5	65	75	25	35
Estherville sandy loam, 6 to 12 percent slopes, moderately eroded	20	25	3	5	-----	-----	20	25	1.0	1.3	55	65	20	30
Estherville sandy loam, 12 to 18 percent slopes	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	20	25
Estherville sandy loam, 18 to 25 percent slopes	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	20	25

See footnotes at end of table.

TABLE 2.—*Predicted average acre yields of principal crops under two levels of management*—Continued

Soil	Corn for grain		Corn for silage		Soybeans		Oats		Rotation hay [1]		Rotation pasture		Permanent pasture	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Cow-acre-days* [2]	*Cow-acre-days* [2]	*Cow-acre-days* [2]	*Cow-acre-days* [2]
Estherville soils, 6 to 12 percent slopes, severely eroded													15	25
Estherville soils, 12 to 25 percent slopes, severely eroded													15	20
Fairhaven silt loam, 0 to 2 percent slopes	50	60	10	12	25	28	50	60	2.5	3.0	115	145	60	75
Fairhaven silt loam, 2 to 6 percent slopes	45	55	9	11	20	25	45	55	2.0	2.5	110	140	55	70
Fairhaven silt loam, 2 to 6 percent slopes, moderately eroded	40	50	8	10	15	20	40	50	1.8	2.5	110	135	50	65
Fairhaven silt loam, 6 to 12 percent slopes, moderately eroded	35	45	7	9	14	16	30	40	1.8	2.2	90	100	40	50
Glencoe silty clay loam:														
Inadequately drained													40	80
Adequately drained	60	75	12	14	30	35	50	60	2.0	2.8	140	160		
Guckeen silty clay loam, 0 to 2 percent slopes	75	85	13	15	30	35	50	60	3.5	4.0	175	200	80	120
Guckeen silty clay loam, 2 to 6 percent slopes	75	85	13	15	30	35	50	60	3.5	4.0	175	200	80	120
Guckeen silty clay loam, 6 to 12 percent slopes	50	65	10	12	20	25	45	55	3.0	3.5	155	185	60	105
Hayden clay loam, 6 to 12 percent slopes, severely eroded	40	55	8	10			25	40	2.0	2.5	100	125	50	70
Hayden clay loam, 12 to 18 percent slopes, severely eroded									1.2	1.6			40	60
Hayden fine sandy loam, 0 to 2 percent slopes	60	70	12	14	25	30	45	55	3.0	3.5	165	195	55	100
Hayden fine sandy loam, 2 to 6 percent slopes	55	65	11	13	20	25	45	55	3.0	3.5	150	180	50	90
Hayden fine sandy loam, 2 to 6 percent slopes, moderately eroded	50	60	10	12	18	22	40	50	2.5	3.0	150	180	55	90
Hayden fine sandy loam, 6 to 12 percent slopes	50	60	10	12	16	20	35	45	2.5	3.0	150	180	50	90
Hayden fine sandy loam, 6 to 12 percent slopes, moderately eroded	40	50	8	10	14	18	30	40	2.0	2.5	130	155	50	80
Hayden fine sandy loam, 12 to 18 percent slopes	40	50	8	10			30	40	1.8	2.0	100	125	50	70
Hayden fine sandy loam, 12 to 18 percent slopes, moderately eroded	35	45	7	9			25	35	1.5	1.8	80	105	45	65
Hayden loam, 2 to 6 percent slopes	65	75	12	14	25	30	50	60	3.0	4.0	165	195	75	115
Hayden loam, 2 to 6 percent slopes, moderately eroded	60	75	12	14	20	28	45	55	3.0	3.7	165	195	75	115
Hayden loam, 6 to 12 percent slopes	60	70	12	14	20	25	45	55	3.0	3.5	155	185	50	100
Hayden loam, 6 to 12 percent slopes, moderately eroded	50	60	10	12	15	20	40	50	2.5	3.0	130	155	65	95
Hayden loam, 12 to 18 percent slopes	45	55	9	10			35	50	2.2	2.7	100	125	50	80
Hayden loam, 12 to 18 percent slopes, moderately eroded	40	50	8	9			30	45	2.0	2.5	80	105	45	65
Hayden loam, 18 to 25 percent slopes													40	60
Hayden loam, 25 to 35 percent slopes													30	55
Hayden soils, 18 to 25 percent slopes, severely eroded													35	60
Hubbard loamy sand, 0 to 2 percent slopes	30	35	6	7	8	10	25	35	1.0	1.5	45	60	20	25
Hubbard loamy sand, 2 to 6 percent slopes	30	35	6	7	8	10	25	35	1.0	1.5	45	60	20	25
Hubbard loamy sand, 2 to 6 percent slopes, moderately eroded	25	30	5	6	6	8	20	30	.6	1.0	30	45	20	25
Hubbard loamy sand, 6 to 12 percent slopes	20	25	4	5			20	25	.4	.8	25	40	15	20
Hubbard loamy sand, 6 to 12 percent slopes, moderately eroded	15	20	3	4			15	20	.4	.8	25	40	15	20
Hubbard loamy sand, 12 to 35 percent slopes, moderately eroded													15	20
Hubbard loamy sand, gravelly subsoil variant, 0 to 2 percent slopes	25	30	5	6	7	9	20	25	.8	1.2	35	50	20	25
Hubbard loamy sand, gravelly subsoil variant, 2 to 6 percent slopes	25	30	5	6	7	9	20	25	.8	1.2	35	50	20	25
Hubbard loamy sand, gravelly subsoil variant, 2 to 6 percent slopes, moderately eroded	20	25	4	5	5	7	18	22	.6	1.0	30	45	20	25
Hubbard loamy sand, gravelly subsoil variant, 6 to 12 percent slopes	15	20	3	4			15	18	.4	.8	25	40	15	20
Hubbard sandy loam, 0 to 2 percent slopes	35	45	7	9	12	14	35	40	1.5	1.8	75	90	35	45
Hubbard sandy loam, 0 to 2 percent slopes, moderately eroded	35	40	7	8	10	12	30	35	1.5	1.8	75	90	30	40
Hubbard sandy loam, 2 to 6 percent slopes	35	40	7	8	10	12	30	35	1.5	1.8	75	90	30	40

See footnotes at end of table.

TABLE 2.—*Predicted average acre yields of principal crops under two levels of management*—Continued

Soil	Corn for grain		Corn for silage		Soybeans		Oats		Rotation hay [1]		Rotation pasture		Permanent pasture	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Cow-acre-days* [2]	*Cow-acre-days* [2]	*Cow-acre-days* [2]	*Cow-acre-days* [2]
Hubbard sandy loam, 2 to 6 percent slopes, moderately eroded	30	35	6	7	8	10	25	35	1.5	1.8	75	90	30	40
Hubbard sandy loam, 6 to 12 percent slopes	28	32	5	6	7	9	25	32	1.2	1.5	65	75	25	30
Hubbard sandy loam, 6 to 12 percent slopes, moderately eroded	25	30	4	5	6	8	20	30	1.2	1.5	60	70	25	30
Lake borders:														
Inadequately drained													50	90
Adequately drained	55	70	11	13	25	30	40	50	2.0	2.5	140	160		
Lester clay loam, 6 to 12 percent slopes, severely eroded	45	60	9	12			35	50	2.2	2.8	105	130	60	85
Lester clay loam, 12 to 18 percent slopes, severely eroded									1.2	1.6			40	60
Lester clay loam, 18 to 25 percent slopes, severely eroded													35	60
Lester loam, 2 to 6 percent slopes	70	80	13	15	30	35	55	65	3.5	4.0	170	200	75	115
Lester loam, 2 to 6 percent slopes, moderately eroded	65	75	12	14	28	32	50	60	3.2	4.0	165	195	75	115
Lester loam, 6 to 12 percent slopes	60	75	12	14	25	30	50	60	3.0	3.5	155	185	60	105
Lester loam, 6 to 12 percent slopes, moderately eroded	55	70	11	13	20	25	45	55	2.8	3.2	135	160	65	100
Lester loam, 12 to 18 percent slopes	50	60	10	12			45	55	2.2	2.8	105	130	55	85
Lester loam, 18 to 25 percent slopes													40	60
Lester loam, 25 to 35 percent slopes													30	55
Lester silt loam, silty variant, 0 to 2 percent slopes	80	90	15	17	32	37	55	70	3.5	4.0	175	200	80	120
Lester silt loam, silty variant, 2 to 6 percent slopes	70	80	13	15	30	35	55	65	3.5	4.0	170	200	75	115
Lester silt loam, silty variant, 2 to 6 percent slopes, moderately eroded	65	75	12	14	28	32	50	60	3.2	4.0	165	195	75	115
Lester silt loam, silty variant, 6 to 12 percent slopes, moderately eroded	55	70	11	13	20	25	45	55	2.8	3.2	135	160	65	100
Lester-Estherville complex, 2 to 6 percent slopes:														
Lester part	70	80	13	15	30	35	55	65	3.5	4.0	170	200	75	115
Estherville part	35	45	7	9	10	12	30	40	1.8	2.0	85	100	40	50
Lester-Estherville complex, 2 to 6 percent slopes, moderately eroded:														
Lester part	65	75	12	14	28	32	50	60	3.2	4.0	165	195	75	115
Estherville part	30	40	6	8	8	10	25	35	1.5	2.0	75	90	30	40
Lester-Estherville complex, 6 to 12 percent slopes:														
Lester part	55	70	11	13			45	55	2.8	3.2	135	160	65	100
Estherville part	20	30	4	6			20	25	1.0	1.3	55	65	25	30
Lester-Estherville complex, 12 to 18 percent slopes:														
Lester part													45	65
Estherville part													20	25
Le Sueur clay loam, 0 to 2 percent slopes	80	90	15	17	32	37	55	70	3.5	4.0	175	200	80	120
Le Sueur clay loam, 2 to 6 percent slopes	80	90	15	17	32	37	55	70	3.5	4.0	175	200	80	120
Marna silty clay loam:														
Inadequately drained	50		10		18		45		1.5				80	100
Adequately drained	75	90	14	17	30	35	55	65	3.0	3.5	175	200		
Marsh														
Milaca loam, 2 to 6 percent slopes, moderately eroded	50	60	10	12	20	25	40	50	2.5	3.0	150	180	60	90
Muck, deep:														
Inadequately drained													30	80
Adequately drained	40	60	11	15	20	25	35	40	2.0	2.5	125	140		
Nessel silt loam, 0 to 2 percent slopes	65	75	12	14	25	30	50	60	3.0	3.5	160	195	60	110
Nessel silt loam, 2 to 6 percent slopes	65	75	12	14	25	30	50	60	3.0	3.5	160	195	60	110
Peat and muck, deep:														
Inadequately drained													30	80
Adequately drained	40	60	10	15	20	25	35	40	2.0	2.5	125	140		
Peat and muck, shallow over loam:														
Inadequately drained													30	80
Adequately drained	50	70	12	17	20	25	35	45	2.0	2.5	125	140		
Peat and muck, shallow over sand													30	55

See footnotes at end of table.

TABLE 2.—*Predicted average acre yields of principal crops under two levels of management*—Continued

Soil	Corn for grain		Corn for silage		Soybeans		Oats		Rotation hay [1]		Rotation pasture		Permanent pasture	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Cow-acre-days* [2]	*Cow-acre-days* [2]	*Cow-acre-days* [2]	*Cow-acre-days* [2]
Rasset and Hubbard soils, 0 to 2 percent slopes:														
Rasset part	40	50	8	10	12	14	40	50	2.0	2.5	75	105	40	50
Hubbard part	35	45	7	9	12	14	35	40	1.5	1.8	75	90	35	45
Rasset and Hubbard soils, 2 to 6 percent slopes:														
Rasset part	35	45	7	9	10	12	30	40	1.5	2.0	75	90	30	40
Hubbard part	35	40	7	8	10	12	30	35	1.5	1.8	75	90	30	40
Rasset and Hubbard soils, 2 to 6 percent slopes, moderately eroded:														
Rasset part	30	40	6	8	8	10	25	35	1.5	2.0	75	90	30	40
Hubbard part	30	40	6	8	10	12	30	35	1.5	1.8	75	90	30	40
Rasset and Hubbard soils, 6 to 12 percent slopes	25	35	6	7	-----	-----	25	30	1.2	1.7	65	75	25	30
Rasset and Hubbard soils, 6 to 12 percent slopes, moderately eroded	25	30	5	6	-----	-----	20	30	1.2	1.5	60	70	25	30
Salida gravelly sandy loam, 2 to 6 percent slopes	15	25	3	5	4	5	20	25	.5	1.0	25	50	20	30
Salida gravelly sandy loam, 6 to 12 percent slopes	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	20	30
Salida gravelly sandy loam, 12 to 35 percent slopes	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	10	20
Salida complex, 2 to 6 percent slopes	15	20	3	4	4	5	20	25	.5	.8	25	35	15	25
Salida complex, 6 to 12 percent slopes	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	15	25
Salida complex, 12 to 35 percent slopes	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	10	15
Sattre silt loam, silty variant, 0 to 2 percent slopes	50	60	10	12	25	28	50	60	2.5	3.0	115	145	60	75
Sattre silt loam, silty variant, 2 to 6 percent slopes	45	55	9	11	20	25	45	55	2.0	2.5	110	140	55	70
Storden-Lester loams, 6 to 12 percent slopes, moderately eroded:														
Storden part	40	50	8	10	16	20	40	45	2.5	3.0	135	160	65	100
Lester part	55	70	11	13	20	25	45	55	2.8	3.2	135	160	65	100
Storden-Lester loams, 12 to 18 percent slopes, moderately eroded:														
Storden part	35	45	7	9	-----	-----	30	35	2.0	2.5	80	105	45	65
Lester part	45	55	9	11	-----	-----	40	50	2.0	2.5	80	105	45	65
Storden-Lester loams, 18 to 25 percent slopes, moderately eroded	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Storden-Lester soils, 6 to 12 percent slopes, severely eroded:														
Storden part	40	50	8	10	-----	-----	35	40	2.0	2.5	105	130	60	85
Lester part	45	60	9	12	-----	-----	35	50	2.2	2.8	105	130	60	85
Storden-Lester soils, 12 to 18 percent slopes, severely eroded	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	40	60
Talcot clay loam:														
Inadequately drained	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	40	80
Adequately drained	55	70	11	14	25	30	40	55	2.0	2.5	140	160	-----	-----
Terril loam, occasionally flooded, 0 to 2 percent slopes	55	65	11	12	28	32	50	60	3.0	3.5	140	165	80	90
Terril loam, sandy substratum, 0 to 2 percent slopes	80	90	15	17	32	37	55	70	3.5	4.0	175	200	90	120
Terril soils, 2 to 6 percent slopes	80	90	15	17	32	37	55	65	3.5	4.0	175	200	90	120
Wadena loam, 0 to 2 percent slopes	45	55	9	11	20	25	45	55	2.0	2.5	105	125	55	70
Wadena loam, 2 to 6 percent slopes	45	55	9	11	20	25	45	55	2.0	2.5	105	125	55	70
Wadena loam, 2 to 6 percent slopes, moderately eroded	40	50	8	10	15	20	40	50	1.8	2.2	100	115	50	65
Wadena loam, 6 to 12 percent slopes, moderately eroded	35	45	7	9	14	16	30	40	1.5	2.0	90	100	40	50
Webster silty clay loam, silty variant:														
Inadequately drained	50	-----	10	-----	18	-----	45	-----	1.5	-----	-----	-----	80	100
Adequately drained	75	90	14	17	30	35	55	65	3.0	3.5	175	200	-----	-----

[1] These yields are to be expected if a mixture of alfalfa and bromegrass is grown; if a mixture of red clover, or alsike clover, and timothy is grown, average yields are 10 to 25 percent less than those shown.

[2] Cow-acre-days is the number of days 1 acre will furnish grazing for 1 cow, steer, or horse; 5 hogs; or 7 sheep or goats without injury to the pasture.

[3] Yields are reduced by floods once in 5 or 6 years.

Woodland [2]

This section gives general facts about woodland in the county. It shows the principal trees native to the county and discusses the soil properties that affect the production of trees. It also discusses the woodland suitability groups and the pests and diseases that affect woodland. The woodland groupings differ markedly from the capability groupings because trees have different requirements than crops.

In 1964, according to the U.S. Bureau of the Census, nearly 58,000 acres in Wright County was woodland. This acreage is less than 15 percent of the land now in farms, and much of it is pastured. Trees can be grown on many of the soils. The sandy soils of the county, however, have the greatest potential for production of trees for commercial purposes, and red pine is more suitable for planting for this purpose than other trees.

A much larger acreage in the county originally was forested. The only open areas were small prairies on outwash plains near Monticello, Clearwater, and Silver Creek. The kinds of original trees and other vegetation are shown in figure 23.[3]

Woodland suitability groups

Management of woodland can be planned more easily if the soils are grouped according to those characteristics

[2] ED HANSES, district forester, State of Minnesota Forest Service, and THOR K. BERGH, woodland conservationist, Soil Conservation Service, assisted in preparing this section.

[3] After the map "The Original Forest of Minnesota," compiled by J. F. MARSCHNER, USDA, in 1930 and in files of the Lake States Forest Experiment Station.

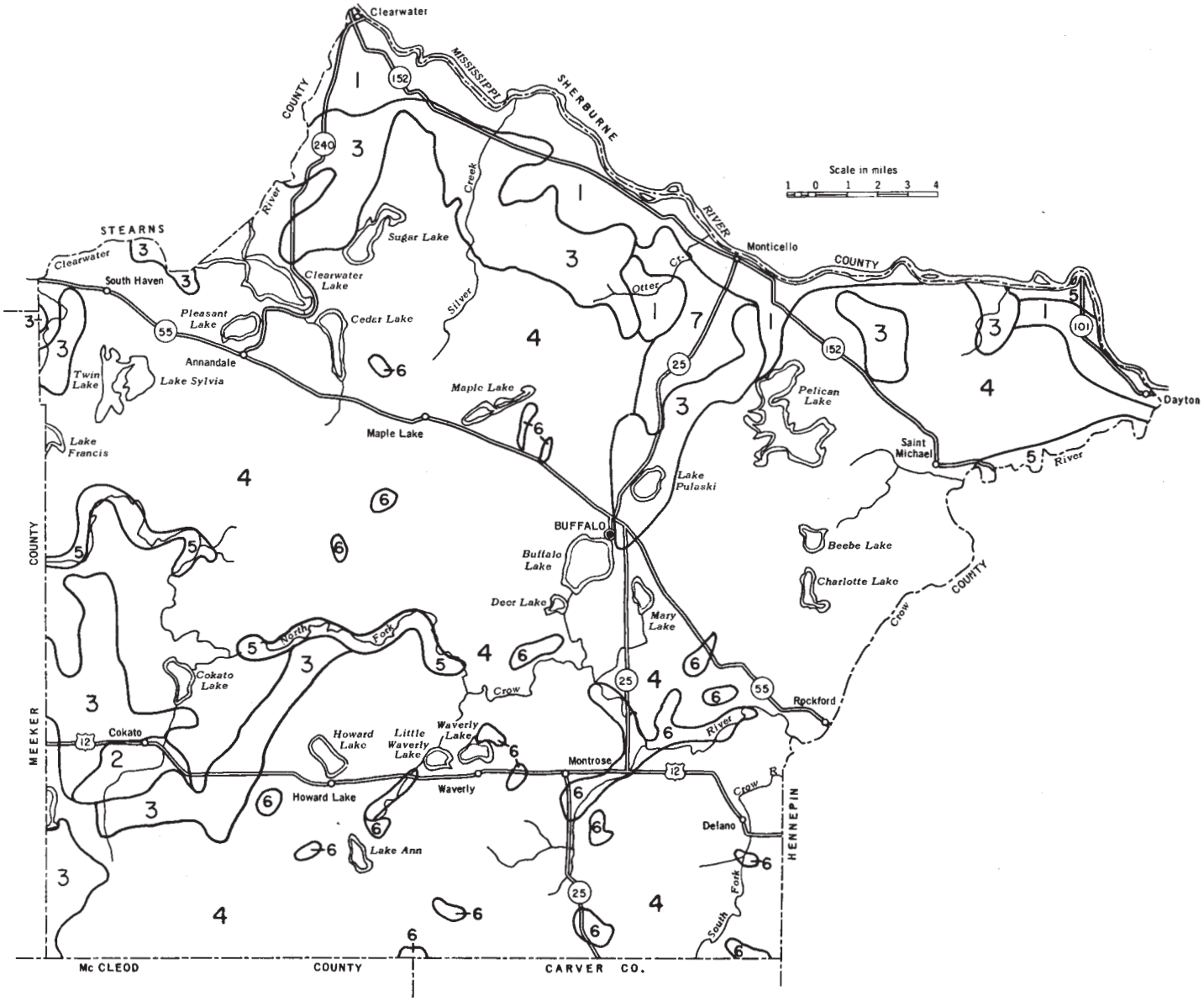

Figure 23.—**The kinds of vegetation in Wright County are (1) oaks; (2) brush-prairie; (3) aspen-oak; (4) northern hardwoods; (5) bottom-land hardwoods; (6) wet prairie; and (7) dry prairie.**

that affect the growth of trees and the management of the stand. For that reason, the soils of the county have been placed in woodland suitability groups. Each group is made up of soils that have about the same suitability for wood crops, require about the same management, and have about the same potential productivity.

The woodland suitability groups in the county are shown in table 3. This table provides productivity ratings for selected species of trees and lists the kinds of trees to favor in existing stands or in new plantings.

Each woodland suitability group in table 3 bears a title that indicates the main characteristics that determine its suitability for trees. Among the most important factors that affect the productive capacity of the soil for growing trees is ability to maintain optimum moisture and to permit the development of an adequate root sys-

TABLE 3.—*Site productivity ratings for multiple use forest, by woodland suitability groups* [1]

Woodland suitability group	Tree species	Site index rating [2]		Suitable species			
				Existing species to favor—		Species for planting—	
		North and east slopes	South and west slopes and flats	North and east slopes	South and west slopes and flats	North and east slopes	South and west slopes and flats
Group 1. Moderately deep and deep, moderately well drained and well drained, medium-textured and moderately fine textured soils; 0 to 6 percent slopes (Bb, FaA, FaB, FaB2, GuA, GuB, HdA, HdB, HdB2, HIB, HIB2, LeB, LeB2, LtB, LtB2, LrA, LrB, LrB2, LuA, LuB, MIB2, NeA, NeB, SeA, SeB, TeA, TIA, TsB, WaA, WaB, WaB2).	Oak	Excellent	Excellent.	Oak, hard maple, basswood, elm, black walnut, red pine, white pine, white spruce.	Oak, hard maple, basswood, elm, black walnut, red pine, white pine, white spruce.	Basswood, black walnut, red pine, white pine, white spruce.	Basswood, black walnut, red pine, white pine, white spruce.
	Hard maple	Good	Good.				
	Basswood	Excellent	Excellent.				
	Elm	Excellent	Excellent.				
	Green ash	Excellent	Excellent.				
	Black walnut.	Good	Good.				
	Red pine	Good	Good.				
	White pine.	Good	Good.				
	White spruce.	Good	Good.				
Group 2. Moderately deep and deep, well-drained, medium-textured and moderately fine textured soils; 6 to 18 percent slopes (FaC2, GuC, HIC, HIC2, HID, HID2, HaC3, HaD3, HdC, HdC2, HdD, HdD2, LcC3, LcD3, LeC, LeC2, LeD, LrC2, SIC2, SID2, StC3, StD3, WaC2).	Oak	Excellent	Fair.	Oak, hard maple, basswood, black walnut, red pine, white pine, white spruce, redcedar.	Oak, basswood, green ash, black walnut, red pine, white pine, white spruce, redcedar.	Basswood, black walnut, white pine, white spruce.	Red pine, redcedar.
	Hard maple.	Good	Poor.				
	Basswood	Excellent	Good.				
	Elm	Excellent	Fair.				
	Green ash	Excellent	Good.				
	Black walnut.	Good	Poor.				
	Red pine	Fair	Fair.				
	White pine.	Good	Poor.				
	White spruce.	Good	Fair.				
	Redcedar [3].	Not applicable.	Not applicable.				
Group 3. Deep, well-drained, medium-textured and moderately fine textured soils; 18 to 35 percent slopes (HIE, HIF, HnE3, LcE3, LeE, LeF, SIE2).	Oak	Excellent	Poor.	Oak, hard maple, basswood, black walnut, red pine, white pine, white spruce, redcedar.	Oak, basswood, red pine, redcedar.	Basswood, black walnut, white pine, white spruce.	Red pine, redcedar.
	Hard maple.	Good	Poor.				
	Basswood	Excellent	Good.				
	Elm	Excellent	Poor.				
	Green ash	Excellent	Fair.				
	Black walnut.	Good	Poor.				
	Red pine	Poor	Fair.				
	White pine	Good	Poor.				
	White spruce.	Good	Poor.				
	Redcedar [3]	Not applicable.	Not applicable.				

See footnotes at end of table.

TABLE 3.—*Site productivity ratings for multiple use forest, by woodland suitability groups* [1]—Continued

Woodland suitability group	Tree species	Site index rating [2]		Suitable species			
				Existing species to favor—		Species for planting—	
		North and east slopes	South and west slopes and flats	North and east slopes	South and west slopes and flats	North and east slopes	South and west slopes and flats
Group 4. Shallow, somewhat excessively drained, moderately coarse textured and medium-textured soils; 0 to 12 percent slopes (BuB, BuB2, BuC, BuC2, BuC3, ByB, ByB2, ByC, ByC2, EmB, EmC, EsA, EsB, EsB2, EsC, EsC2, EtA, EtB, EtB2, EtC, EtC2, EvC3, HuA, HuA2, HuB, HuB2, HuC, HuC2, LtC, RhA, RhB, RhB2, RhC, RhC2).	Oak Basswood Elm Green ash Red pine White pine White spruce. Redcedar [3]	Fair Good Fair Good Fair Fair Fair. Not applicable.	Poor. Fair. Poor. Fair. Fair. Poor. Fair. Not applicable.	Oak, basswood, green ash, red pine, white pine, white spruce, redcedar.	Oak, basswood, green ash, red pine, redcedar.	Red pine, white pine, white spruce, redcedar.	Red pine, redcedar.
Group 5. Shallow, mostly somewhat excessively drained, moderately coarse textured soils; 12 to 35 percent slopes (BuD, BuD3, BuE, ByD, ByE, EmD, EmE, EtD, EtE, EvE3, LtD).	Oak Basswood Elm Green ash Red pine White pine. White spruce. Redcedar [3]	Fair Fair Fair Fair Fair Fair Fair Not applicable.	Poor. Fair. Poor. Poor. Poor. Poor. Poor. Not applicable.	Oak, basswood, white pine, white spruce.	Oak, basswood, red pine, redcedar.	White pine, white spruce.	Red pine, redcedar.
Group 6. Deep, excessively drained loamy sands and fine sands; 0 to 12 percent slopes (BhB2, BhC2, BrA, BrB, BrC, ChB, ChC, HrA, HrB, HrB2, HrC, HrC2).	Oak Aspen White pine Red pine Jack pine White spruce. Redcedar [3]	Poor Poor Fair Good Good Good Not applicable.	Poor. Poor. Fair. Good. Good. Good. Not applicable.	White pine, red pine, jaek pine, white spruce, redcedar.	White pine, red pine, jack pine, white spruce, redcedar.	White pine, red pine, white spruce, redcedar.	White pine, red pine, white spruce, redcedar.
Group 7. Deep, somewhat excessively drained and excessively drained fine sands and loamy sands; 12 to 35 percent slopes (BhD, ChD, HrE2).	Oak Aspen White pine Red pine Jack pine White spruce. Redcedar [3]	Poor Poor Poor Fair Fair Fair Not applicable.	Poor. Poor. Poor. Fair. Fair. Poor. Not applicable.	White pine, red pine, jack pine, white spruce, redcedar.	White pine, red pine, jack pine, white spruce, redcedar.	White pine, red pine, white spruce.	Red pine, redcedar.
Group 8. Shallow and very shallow, somewhat excessively drained and excessively drained sandy and gravelly soils; 0 to 12 percent slopes (HsA, HsB, HsB2, HsC, SaB, SaC, ScB, ScC).	Oak Aspen Birch White pine. Redpine Jack pine White spruce. Redcedar [3]	Poor Poor Poor Poor Fair Fair Fair Not applicable.	Poor. Poor. Poor. Poor. Poor. Fair. Poor. Not applicable.	White pine, red pine, jack pine, white spruce, redcedar.	Red pine, jack pine, redcedar.	Red pine, redcedar.	Jack pine, redcedar.

See footnotes at end of table.

TABLE 3.—*Site productivity ratings for multiple use forest, by woodland suitability groups* [1]—Continued

Woodland suitability group	Tree species	Site index rating [2]		Suitable species			
				Existing species to favor—		Species for planting—	
		North and east slopes	South and west slopes and flats	North and east slopes	South and west slopes and flats	North and east slopes	South and west slopes and flats
Group 9. Very shallow, excessively drained sandy and gravelly soils; 12 to 35 percent slopes (SaE, ScE).	Oak	Poor	Poor.	All vegetation growing in the areas.	All vegetation growing in the areas.	Red pine, white spruce, redcedar.	Jack pine, redcedar.
	Aspen	Poor	Poor.				
	Birch	Poor	Poor.				
	Red pine	Poor	Poor.				
	Jack pine	Poor	Poor.				
	White spruce.	Poor	Poor.				
	Redcedar [3].	Not applicable.	Not applicable.				
Group 10. Deep and moderately deep, somewhat poorly drained and poorly drained, medium textured and moderately fine textured soils on flats (Bc, Bd, Ca, Cs, Cw, De, Dn, Du, Ma, We).	Elm	Good	Good.	Elm, basswood, oak, soft maple, cottonwood.	Elm, basswood, soft maple, oak, cottonwood.	Basswood, soft maple, cottonwood.	Basswood, soft maple, cottonwood.
	Basswood.	Good	Good.				
	Oak	Good	Good.				
	Soft maple.	Good	Good.				
	Cottonwood.	Excellent	Excellent.				
	Black ash.	Good	Good.				
	Aspen	Excellent	Excellent.				
Group 11. Soils that have a very high water table and that are wet or are flooded frequently (Al, Ba, Be, Cn, Co, Cp, Gc, Lb, Mh, Mu, Pa, Pm, Ps, Tc).	Not suited to trees.						

[1] A multiple use forest is one that is used for production of wood and for scenic value, and to provide food and cover for wildlife, protection for the watershed, and opportunities for recreation.

[2] Interpretations of adjective ratings are given in table 4.

[3] No site index rating is given for redcedar; redcedar ordinarily is not used for production of wood but for scenic, wildlife, and watershed purposes.

tem. Other significant characteristics are the thickness of the surface layer of the soil, the natural supply of plant nutrients, the texture and consistence of the soil material, the aeration, the drainage, and the depth of the water table.

In this county drainage is an important factor affecting the suitability of a site for trees. The soils have been classified, according to drainage, as excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained. On excessively drained soil, pines generally are more suitable than hardwoods. On the somewhat poorly drained, poorly drained, and very poorly drained soils, most trees do not thrive.

In the steeper areas trees grow better on slopes that face north and east than on slopes that face south and west, because north- and east-facing slopes are cooler and more moist. The coves where slopes face north or east are even more desirable for trees.

The ratings in table 3 are based chiefly on the experience and judgment of local soil scientists, woodland conservationists, and foresters. They represent the best information now available about the way soil influences the growth and management of trees. The ratings are tentative and are subject to revision as more information becomes available.

The major limitations of the woodland suitability groups are defined as follows.

Seedling mortality refers to the expected degree of mortality of seedlings as influenced by the kind of soil. Mortality is *slight* if adequate natural regeneration ordinarily takes place. It is *moderate* if natural regeneration cannot always be relied upon for adequate and immediate restocking. It is *severe* if much replanting, special seedbed preparation, and superior planting techniques are needed to assure adequate restocking.

The expected hazard from competition by other plants is also given a rating of slight, moderate, or severe. A rating of *slight* means that competition from other plants is no special problem; of *moderate*, that plant competition develops but generally does not prevent an adequate stand from becoming established; and of *severe*, that plant competition prevents trees from restocking naturally.

The soil characteristics that restrict or prohibit the use of equipment commonly used in tending and harvesting

the trees are also given according to the terms slight, moderate, or severe. A rating of *slight* means there is no restriction in the kind of equipment or in the time of the year it is used; *moderate* means there is a seasonal restriction of less than 3 months in using the equipment and that the equipment can be expected to damage the roots of the trees to some extent; and *severe* means there is a seasonal restriction of more than 3 months in the use of equipment and that the equipment can be expected to cause severe damage to the roots of the trees.

Erosion hazard refers to the potential erosion hazard of the soil when it is managed according to currently acceptable standards. The ratings are based on the increasing risk of erosion.

In table 4 the relative terms for productivity that are given in table 3 are converted to site indexes for basswood and several other kinds of trees. Site index indicates productivity of trees more specifically than the verbal rating. This index is the average height attained by dominant and codominant trees in a relatively pure, even-aged stand at 50 years of age. The index reflects the combined effect of different factors of the environment on growth of trees. For example, soil areas in woodland group 1 on north and east slopes are rated in table 3 as having "excellent" productivity. By referring to table 4 one can see that basswood, with a rating of excellent, has a site index of 70, or averages about 70 feet in height at 50 years of age.

TABLE 4.—*Site index and species of trees*

Species	Site index [1]					
	30 feet	40 feet	50 feet	60 feet	70 feet	80 feet
Black ash	Poor	Fair	Good	Excellent		
Green ash	Poor	Fair	Good	Excellent		
Aspen		Poor	Fair	Good	Excellent	
Basswood		Poor	Fair	Good	Excellent	
Birch		Poor	Fair	Good	Excellent	
Black walnut		Poor	Fair	Good	Excellent	
Cottonwood			Poor	Fair	Good	Excellent.
Elm		Poor	Fair	Good	Excellent	
Hard maple	Poor	Fair	Good	Excellent		
Soft maple			Poor	Fair	Good	Excellent.
Oak		Poor	Fair	Good	Excellent	
Jack pine		Poor	Fair	Good	Excellent	
Red pine		Poor	Fair	Good	Excellent	
White pine			Poor	Fair	Good	Excellent.
White spruce		Poor	Fair	Good	Excellent	

[1] Height attained by dominant and codominant trees in relatively pure, even-aged and well-stocked stands at the age of 50 years. Height reflects the combined effect of different environment factors and is used as a measure of productivity.

Woodland pests and diseases.—All wooded areas are subject to damage by insects, animal pests, and diseases. The insects include defoliators, leaf miners, sucking insects, and twig and stem borers. Wild animal pests are mice, moles, gophers, rabbits, and deer. The most serious disease is oak wilt. White pine blister rust is a minor hazard, but the hazard of Dutch Elm disease is increasing.

No effective control of oak wilt is available, and stands that are affected generally should be converted to pine. Planting white pine on upper slopes and ridgetops, in open fields, and under a canopy of oak on sandy or dry ridgetops helps in control of white blister rust. Control of Dutch Elm disease is difficult, and local forestry authorities should be consulted.

Little relationship can be established between the kind of soil and the prevalence of woodland pests and diseases. Damage caused by pocket gophers, however, is more severe on sandy soils, such as the Hubbard and Estherville, than on other soils. Measures for control of insects, pests, and diseases should be started when the trees are young and most susceptible to damage. On plantations, closer, more careful management generally is required to obtain control than is needed in natural woodland.

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WOODLAND GROUP 1

Soils in this group are moderately deep and deep, moderately well drained and well drained, and medium textured and moderately fine textured. Slopes are 0 to 6 percent. The natural supply of plant nutrients is moderate to high, and the content of organic matter is moderately low to high. Permeability is moderately rapid to moderately slow, and the moisture-supplying capacity is moderate to high.

These soils are among the most productive in the county. Wooded pastures and small, unmanaged woodlots are on many of the Hayden, Lester, and Le Sueur soils, though most areas are in crops. The principal trees are basswood, hard maple, bur oak, elm, boxelder, white oak, red oak, and ash. Because of their greater value for crops, these soils generally are not planted to trees, but they are well suited to trees of good quality. If it is desirable to develop woodland, see table 3 for trees to plant or to favor in the present woodlots.

Seedling mortality generally is slight on these soils, and less than 25 percent of the planted stock is lost. Natural regeneration generally is adequate.

Competition from other plants is severe. When preparing the site, furrowing, scalping, and spraying gen-

erally are needed to keep competing plants from smothering the seedlings. In areas where trees regenerate naturally and the site has deteriorated because of fire or overgrazing, disking or other seedbed preparation is needed for a satisfactory stand of trees. If such methods are not successful, it may be necessary to set out young seedlings or sow seed under the existing stand.

Equipment limitation is slight. Work can be done at any time during the year, except just after a heavy rain and for a short period in spring, during and following snowmelt.

The hazard of erosion is slight if a protective cover of vegetation is kept on these soils.

WOODLAND GROUP 2

In this group are moderately deep and deep, well-drained, medium-textured and moderately fine textured soils. Slopes range from 6 to 18 percent. The natural supply of plant nutrients is moderate to high, and the content of organic matter is low to high. Permeability is moderate to moderately rapid.

The principal trees on soils in this group are basswood, hard maple, elm, bur oak, boxelder, white oak, red oak, and ash. The trees are in woodland that is pastured or are in small, unmanaged woodlots. Such tracts are common on all soils in this unit, but particularly on the Lester and Hayden soils.

Seedling mortality generally is slight, and less than 25 percent of the planted stock is lost. Natural regeneration generally is adequate.

Competition from other plants is severe. Furrowing, scalping, and spraying are needed in places to keep competing plants from smothering the seedlings. In areas where trees regenerate naturally, disking or other preparation of the site is needed in places for a satisfactory stand of trees.

Equipment limitation is slight. Work can be done at any time during the year, except just after a heavy rain and for a short period in spring, during and following snowmelt.

The hazard of erosion is greater on these soils than on soils in woodland group 1 because slopes are steeper. A protective cover of vegetation needs to be kept on these soils.

WOODLAND GROUP 3

This group consists of deep, well-drained, medium-textured and moderately fine textured soils. Slopes range from 18 to 35 percent. Fertility is moderate to high, and the content of organic matter is low to medium. Permeability is moderate to moderately rapid, and the moisture-supplying capacity is moderately high. Runoff is very rapid, however, and thus the amount of water that enters the soils is reduced.

The principal trees on soils in this group are basswood, hard maple, elm, bur oak, white oak, red oak, quaking aspen, and birch.

Seedling mortality is slight to moderate, and generally less than 25 percent of the planted stock is lost. For natural regeneration on the less sloping soils, it may be desirable to prepare the seedbed enough so that the seedlings can be planted in mineral soil. Seedlings must be planted by hand because of the strong slopes.

Competition from other plants is moderate to severe. Furrowing, scalping, and spraying are needed in places to keep competing plants from smothering the seedlings.

Soils in this group generally are too steep for mechanical tree-planting equipment, and care is needed to prevent the equipment from tipping. Limitations to use of other equipment are moderate to severe. Work can be done on these soils throughout most of the year, except after a heavy rain and in spring during and following a thaw.

Because of the strong slopes, the hazard of erosion is severe on these soils and a protective cover of vegetation is needed.

Trees on these soils have value for production of wood. They also protect the watershed, provide food and cover for wildlife, and have esthetic value.

WOODLAND GROUP 4

Soils in this group are shallow, somewhat excessively drained, and moderately coarse textured and medium textured. Slopes are 0 to 12 percent. These soils are somewhat droughty. They are underlain by sand and gravel within a depth of 24 inches. Fertility is moderately low to moderately high, and the content of organic matter is low to high. Permeability is moderately rapid, and moisture-supplying capacity is low.

Except for the Burnsville soils and the Burnsville-Hayden and Emmert-Milaca complexes, few areas of these soils are wooded. The principal trees are hard maple, basswood, oak, elm, and ash, but all the soils are well suited to pine.

Seedling mortality is slight to moderate, and less than 25 percent of the planted stock is lost. Natural regeneration is adequate in places, but it would be better to convert the stands of hardwoods to pine.

Competition from other plants is slight to moderate. Where the site is brushy or the hardwoods are of a kind not suited to the soils, the existing woody vegetation must be eliminated by girdling, clearing, and spraying before planting conifers. Furrowing or scalping are also necessary.

Equipment limitation is slight. Work can be done at any time during the year, except just after a heavy rain and in spring during and following snowmelt.

Soils in this group are subject to erosion unless a protective cover of vegetation is kept on them.

WOODLAND GROUP 5

This group consists of shallow, moderately coarse textured and medium-textured soils that are mostly somewhat excessively drained. Slopes range from 12 to 35 percent. The substratum is sandy and gravelly and is within a depth of 24 inches. The natural supply of plant nutrients and the content of organic matter are low. Permeability is moderately rapid, and the moisture-supplying capacity is low.

The principal trees on soils in this group are oaks that are not suited to the soils and quaking aspen, but in some places hard maple, basswood, elm, and ash trees grow. These soils are not suited to hardwoods, because they are droughty and are low in fertility. On these soils more wood is produced from conifers than from hardwoods. Stands of hardwoods should be converted to conifers, but careful management is needed to prevent regrowth

of hardwoods. The kinds of trees to favor in existing stands and those to choose for planting are given in table 3.

Seedling mortality is slight to moderate, and less than 25 percent of the planted stock generally is lost. If a dry period follows planting, however, more than 25 percent of the seedlings are likely to be lost, and replanting must be done.

Competition from other plants is slight. Hardwoods and brush can be controlled by girdling or spraying. If conifers are hand planted, furrowing or scalping is needed in places to prepare the seedbed enough that the seedlings can be planted.

Because of the steep slopes, the equipment limitation is moderate to severe. Some of the slopes are too steep for mechanical tree-planting equipment, and care is needed to keep the equipment from tipping. Work can be done on these soils throughout most of the year, except after a heavy rain and in spring during and following a thaw.

The hazard of erosion is severe, and a protective cover of vegetation must be kept on these soils.

Trees on these soils have value for wood products. They also protect the watershed, provide food and cover for wildlife, and have esthetic value.

WOODLAND GROUP 6

This group consists of deep, somewhat excessively drained and excessively drained loamy sands and fine sands. Slopes are 0 to 12 percent. Fertility and content of organic matter generally are low. Permeability is rapid, and the moisture-supplying capacity is low.

Soils in this group are not suitable for hardwoods, because they are droughty and are low in fertility. Only a few areas are wooded, and the trees are mostly oak not suited to these soils. More wood is produced from conifers on these soils than from hardwoods (fig. 24). Stands of hardwoods should be converted to conifers, and the kinds of trees to favor in existing stands and those to choose for planting are given in table 3.

Figure 24.—**The white pines on this Hubbard loamy sand are 15 years old, in contrast to the northern bur oaks, which are 60 years old.**

Figure 25.—**Oak of poor quality on Hubbard loamy sand, 12 to 35 percent slopes, moderately eroded.**

Seedling mortality ranges from slight to severe, depending on the moisture available and the preparation of the site. Survival of pine seedlings generally is good if a few good rains fall after planting, but if rainfall is scarce, loss of planting stock is high. Scalping and furrowing are needed in preparing a site for planting. Furrowing, in particular, helps to collect the water needed for the planted trees.

Competition from other plants is slight. Except during seasons of high rainfall, grasses and weeds generally are sparse. Where the stands consist of brush and of oak not suited to the soils, girdling, clearing, or spraying is needed to remove the trees and brush before planting conifers.

Because these soils are sandy, use of some kinds of equipment is limited, even though the equipment is light. Work can be done during most of the year, but if logging is done in summer, roots of trees are likely to be damaged.

These soils are subject to erosion, and a protective cover of vegetation must be kept on them. Mulching with straw or hay and lightly disking before planting help to protect seedlings from wind.

Field windbreaks are needed in some places. A windbreak of one row of jack pine or red (Norway) pine alone can be used, or two or three rows of jack and red (Norway) pine can be used. Redcedar can be used if planted on the sunny side of a three-row or two-row windbreak.

WOODLAND GROUP 7

Soils in this group are deep, somewhat excessively drained and excessively drained fine sands and loamy sands. Slopes range from 12 to 35 percent. Fertility, content of organic matter, and moisture-supplying capacity generally are low in all of these soils. Permeability is rapid.

The trees on the soils in this group are mostly oak that is not suited to these soils, but redcedar grows in some places (fig. 25). Red (Norway) pine is a more suitable tree for these soils.

These soils are too droughty for hardwoods, and they also lack sufficient plant nutrients for such trees. Pines or redcedars on these soils produce more wood and better cover than hardwoods. Stands of hardwoods should be converted to conifers, and the kinds to favor in existing stands and those to choose for planting are given in table 3.

Seedling mortality ranges from slight to severe, depending on the moisture available and preparation of the site. Survival of planted stock is good if furrowing and scalping are used in preparing the seedbed and if a few good rains come after planting. Loss of planted stock is high, however, if a prolonged dry period follows planting.

Competition from trees and brush is slight, but a sparse growth of grasses and weeds competes severely for moisture with planted stock. Before planting pines, oak and brush should be removed by girdling, clearing, or spraying. Scalping and furrowing are also needed. Furrowing in particular helps to collect water needed for the planted stock.

Because of the strong slopes, equipment limitation is moderate to severe, and care is needed to keep the equipment from tipping. Mechanical tree-planting equipment generally cannot be used on slopes of more than 12 percent. Use of equipment in summer is limited because these soils are loose and sandy.

Keeping a cover of permanent vegetation on these soils helps to prevent further erosion. Mulching with straw or hay helps to control erosion and also protects the new seedlings.

Trees on these soils have value for wood products. They also protect the watershed, provide food and cover for wildlife, and have esthetic value.

WOODLAND GROUP 8

In this group are shallow and very shallow, somewhat excessively drained and excessively drained sandy and gravelly soils. Slopes are 0 to 12 percent. All of these soils are droughty and have low moisture-supplying capacity. The supply of plant nutrients and content of organic matter are also low. Permeability is rapid to very rapid.

The principal trees on soils in this group are oaks that are not suited to these soils, but quaking aspen and birch grow in some places. These soils are too droughty for hardwoods and lack sufficient nutrients for such trees. More wood is produced from conifers on these soils than from hardwoods. Stands of hardwoods should be converted to conifers, but good management is needed to prevent regrowth of hardwoods. Suitable conifers for planting or to favor in existing stands are given in table 3.

WOODLAND GROUP 9

This group consists of excessively drained, sandy and gravelly soils that are very shallow over gravel and sand. Slopes range from 12 to 35 percent. These soils are droughty. The natural supply of plant nutrients, content of organic matter, and moisture-supplying capacity are low. Permeability is rapid to very rapid.

The principal trees on soils in this group are oaks that are not suited to these soils, but quaking aspen and birch grow in some places. These soils are too droughty for hardwoods and lack sufficient nutrients for such trees. Areas now wooded should be converted to conifers. The kinds of trees to favor in existing stands and those to choose for planting are given in table 3.

Seedling mortality ranges from moderate to severe, depending on the moisture available. More than 75 percent of the planted stock is likely to be lost if a dry period follows planting. For more than 50 percent of the planted stock to survive, a few good rains are needed after planting. Much replanting generally is needed.

Competition from other plants is slight. Growth of grasses and weeds is sparse, and these plants offer little competition to planted stock. Before planting pines, girdling, clearing, or spraying is needed to remove the hardwoods.

Mechanical tree-planting equipment cannot be used on slopes of more than 12 percent. Care is needed to keep equipment from tipping on steep and very steep slopes, and also to keep tractors from going out of control and logs from rolling downslope. Damage to roots of trees generally is slight in winter, but in summer logging is likely to damage the roots.

A cover of permanent vegetation that is well maintained is needed on these soils for control of erosion. Avoid clear cutting of wooded areas. Mulching with straw or hay helps control erosion and also protects new seedlings.

Trees on these soils have value for wood products. They also protect the watershed, provide food and cover for wildlife, and have esthetic value. All wooded areas must be protected from fire and grazing.

WOODLAND GROUP 10

This group consists of deep and moderately deep, somewhat poorly drained and poorly drained, medium-textured and moderately fine textured soils on flats. The fertility and content of organic matter are high, and permeability is moderate to slow. The moisture-supplying capacity is high, except in the Biscay variant and in the Duelm soils. The seasonal water table is fairly high, however, and helps replenish moisture.

If the soils in this group are adequately drained, they are productive of crops. Wooded pasture and unmanaged woodland are on many of the Dundas, Ames, and Cordova soils, though most areas are in crops (fig. 26).

Figure 26.—**A typical wooded pasture on Cordova and Webster silty clay loams.**

Because of their greater value for crops, these soils generally are not planted to trees, though they are well suited to trees of high quality. If it is desirable to develop woodland, see table 3 for trees to favor in existing stands or for those to choose for planting.

Seedling mortality is slight, and less than 25 percent of the planted stock is lost. Natural regeneration is adequate in places, but disking and other preparation of the seedbed are needed in places to obtain a satisfactory stand of desirable trees.

Competition from grasses and weeds on these soils is severe. Furrowing, scalping, or spraying is needed when preparing the site for planting to keep competing plants from smothering the seedlings.

Limitations to use of equipment are slight to moderate on soils in this unit. These soils are so wet and sticky that the machines used in tending or harvesting trees cannot move over them for several days after a rain. Equipment should also be kept off in spring after a thaw until the soils are dry and firm. The hazard of erosion is slight on all soils in this group.

WOODLAND GROUP 11

Soils in this group are too wet for trees. All of them have a very high water table and are always wet or are flooded frequently. Some of the soils are deep and silty and are in small depressional areas; other areas consist of large peat bogs or of marsh and old river channels. Unless these soils have been drained or protected from flooding, water generally stands on them for long periods. Drained areas are well suited to crops, and it would not be economically feasible to use such areas for trees.

Wildlife [4]

The principal game in Wright County are ring-necked pheasant, various kinds of waterfowl, and deer. Their number appear to be related to the soil associations in the county and to the land use. The main areas for pheasant, waterfowl, and deer in the county are shown in figure 27. The soil associations are described in the section "General Soil Map," and their location is shown on the general soil map at the back of this report.

Pheasant are more numerous in wildlife area 1 in the southern part of the county, south of U.S. Highway No. 12, than in other parts of the county. Here the Lester-Le Sueur-Cordova and the Lester-Hayden-peat soil associations are predominant, and the dominant capability classes are II and III. Soils in wildlife area 1 are nearly level to gently sloping. Winter cover is adequate in most parts of the area. In some places, however, good cover is needed that is protected from fire and grazing and can be used as nesting areas by pheasant.

Wildlife area 2 is a large area of rolling soils, just north of area 1 and west of Buffalo. This area is fair for pheasant. Here the Lester-Hayden-peat soil association is predominant, though small tracts of other soil associations are included. Fewer pheasant are attracted to this area than to area 1, since it is more wooded and less of it is cultivated.

The northeastern part of the county near Pelican Lake and along the Mississippi and Crow Rivers makes up wildlife area 3, which is good habitat for waterfowl. Much of the area consists of the Hayden-Dundas-peat soil association, but smaller areas are made up of the Estherville-Hubbard-Wadena or the Hayden-Lester-peat soil association. Capability classes II and III are dominant. Drainage is a problem in more than 40 percent of wildlife area 3, and many farm ponds have been constructed in the area. The ponds improve the habitat for waterfowl, but many more are needed. Providing loafing sites for waterfowl in each farm pond helps to attract more ducks to the area.

Fair habitat for waterfowl is provided in wildlife area 4. This large area reaches from the Crow River in the southeastern part of the county to the Clearwater River in the northwestern part and is east of Buffalo. The Estherville-Hubbard-Wadena and the Hayden-Lester-peat soil associations are predominant in the area, and capability classes II, III, and IV are dominant. The area contains many lakes and marshes. Drainage is a problem in about one-fourth of the area.

Good habitat for white-tailed deer is provided in the two parts of the county that make up wildlife area 5. One part is adjacent to the Mississippi River in the northern part of the county, and the other is in the northwestern part of the county near Clearwater River. Both areas are mostly wooded. The Hayden-Lester-peat and the Burnsville-Hayden-peat soil associations are predominant. Capability classes III, IV, and VI are dominant. The soils in area 5 are strongly rolling to steep and hilly. Slopes are uneven and complex. They can be improved for deer if grazing cattle are kept out of the wooded areas.

Use of crop rotations and stripcropping, seeding banks of ditches and field borders, and similar conservation practices are needed to provide a diversity of cover and improve the areas for wildlife. Improving farmstead windbreaks and seeding odd areas to grass also help to provide food and nesting cover for wildlife. In addition the nesting areas must be protected from grazing and from wildfire.

Engineering Uses of the Soils

This section describes the properties of the soils that are important to engineering. Soil properties are of special interest to engineering because they affect the construction and maintenance of highways, airports, pipelines, building foundations, facilities for storing water, controlling erosion, draining and irrigating soils, and disposing of sewage.

The properties most important to the engineer are permeability, shear strength, compaction characteristics, soil drainage, shrink-swell characteristics, grain size, plasticity, and soil reaction, or pH. Topography and depth to water table, to bedrock, or to sand and gravel are also important.

Some of the properties of soil important to engineering are described in this section. The information can

[4] HANS UHLIG, biologist, Soil Conservation Service, assisted with this section.

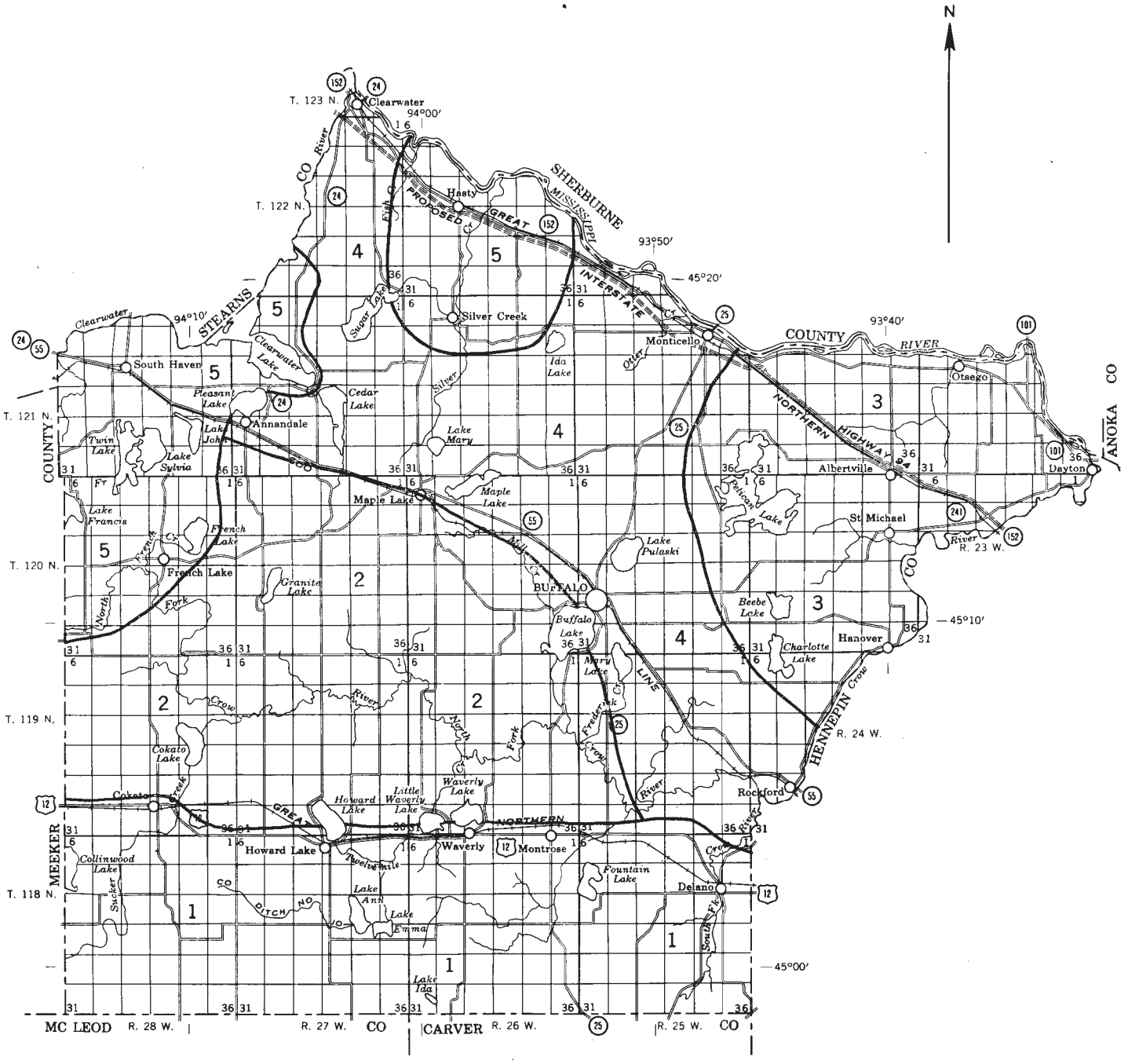

Figure 27.—**Diagram showing wildlife areas in Wright County. Area 1 is good for ring-necked pheasant and area 2 is fair for this bird; area 3 is good for waterfowl and area 4 is fair for waterfowl; area 5 is good for deer.**

be used by engineers along with other information in the report to—

1. Make soil and land use studies that will aid in selecting and developing sites for industrial, business, residential, and recreational uses.
2. Make estimates of the engineering properties of soils for use in the planning of agricultural drainage systems, waterways, farm ponds, irrigation systems, terraces or diversions, and other structures for conserving soil and water.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways, airports, pipelines, cables, and sewage disposal fields and in planning detailed surveys of the soils at the selected locations.
4. Locate probable sources of sand, gravel, and other materials for use in construction.
5. Correlate performance of engineering structures with the soil mapping units and thus develop information for overall planning that will be

useful in designing and maintaining the structures.

6. Determine the suitability of the soils for cross-country movement of vehicles and construction equipment.
7. Supplement information obtained from other published maps, reports, and aerial photographs for the purpose of making maps and reports that can be used readily by engineers.
8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

Used with the soil map to identify the soils, the engineering interpretations in this section can be useful for many purposes. It should be emphasized that the interpretations may not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads or where the excavations are deeper than the depths of layers here reported. Nevertheless, even in such situations, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that can be expected.

Some of the terms used by the soil scientist may be unfamiliar to the engineer, and some words, for example, soil, clay, silt, and sand, may have special meanings in soil science. These and other special terms that are used are defined in the Glossary at the back of the report.

Some of the information useful for engineering can be obtained from the soil map. For more information on the soils, however, it is necessary to refer to other parts of the report, particularly to the sections "Descriptions of the Soils" and "Formation, Classification, and Morphology of Soils." By using the information in the soil survey report, the soils engineer can concentrate on the most suitable soils for engineering purposes. Then a minimum number of soil samples will be needed for laboratory testing and an adequate investigation can be made at minimum cost.

Engineering classification systems

Agricultural scientists of the United States Department of Agriculture classify soils according to texture. In some ways this system of naming textural classes is comparable to the two systems used by engineers for classifying soils, that is, the system of the American Association of Highway Officials (AASHO) and the Unified system. Following is a description of the classification systems used by engineers. Additional information is given in the PCA Soil Primer (*11*).[5]

Most highway engineers classify soil materials in accordance with the system approved by the American Association of State Highway Officials (*1*). In this system soil materials are classified in seven principal groups. The groups range from A–1 (gravelly soils of high bearing capacity, the best soils for subgrade) to A–7 (clay soils having low strength when wet, the poorest soils for subgrade). Within each group, the relative engineering value of the soil material is indicated by a group index number. Group index numbers range from 0 for the best material to 20 for the poorest. The next to last column of table 5 shows the group number for the soils tested. The numbers are in parentheses following the AASHO group symbol. The estimated AASHO classification for all the soils of the county is given in table 6.

Some engineers prefer to use the Unified soil classification system (*19*). In this system soil materials are identified as coarse grained, eight classes; fine grained, six classes; and highly organic. The last column of table 5 gives the classification of the tested soils, according to the Unified system. The estimated classification of all the soils of the county, according to the Unified system is given in table 6.

Soil test data

Soil samples from three important series in the county were tested by standard procedures to help evaluate the soils for engineering purposes. The tests were performed by the Minnesota Department of Highways in cooperation with the U.S. Department of Commerce, Bureau of Public Roads. The samples were taken from nine locations selected by the Soil Conservation Service, and the soils were sampled at three different locations. An effort was made to include the central (modal) concept in the samples taken, as well as the ranges (minimal and maximal) that occur in this county. The results of the tests made on the samples and the classification of each sample, according to both the AASHO and Unified systems, are given in table 5.

The engineering classifications in table 5 are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods. Percentages of clay obtained by the hydrometer method should not be used in naming textural classes for soil classification. The information is useful, however, in determining general engineering properties of the soils.

Moisture density, the relation of moisture content and the density to which a soil material can be compacted, is also given in table 5. If a soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material increases until the optimum moisture content is reached. After that the density decreases with increase in moisture content. The highest dry density obtained in the compaction test is termed maximum dry density. Moisture-density data are important in earthwork, for, as a rule, optimum stability is obtained if the soil is compacted to about the maximum dry density when it is at approximately the optimum moisture content.

The tests to determine liquid limit and plastic limit measure the effect of water on the consistence of the soil material. As the moisture content of a clayey soil increases from a very dry state, the material changes from a semisolid to a plastic state. As the moisture content is further increased, the material changes from a plastic to a liquid state. The *plastic limit* is the moisture content at which the soil material passes from a semisolid to a plastic state. The *liquid limit* is the moisture content at which the material passes from a plastic to a liquid state. The *plasticity index* is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which

[5] Italic numbers in parentheses refers to Literature Cited, p. 140.

TABLE 5.—*Engineering*

[Tests performed by the Minnesota Department of Highways in cooperation with the U.S. Department of Commerce, Bureau of

Soil name and location	Parent material	Minnesota report No. SS61	Depth	Horizon	Moisture-density [1]	
					Maximum dry density	Optimum moisture
			Inches		*Lb./cu. ft.*	*Percent*
Dundas silt loam:						
NW¼NW¼ sec. 2, T. 119 N., R. 25 W. (Modal profile.)	Till on ground moraine (Mankato age).	162	0–4	A1	76	33
		163	19–26	B23g	86	27
		164	42–60	C2g	112	15
SW¼NE¼ sec. 10, T. 120 N., R. 24 W. (Maximal profile.)	Till on ground moraine (Mankato age).	165	2–8	A2	99	20
		166	20–30	B23g	84	30
		167	42–54	C2g	88	29
SW¼SW¼ sec. 1, T. 119 N., R. 28 W. (Minimal profile.)	Till on ground moraine (Mankato age).	159	0–7	A1	83	28
		160	16–24	B22g	87	26
		161	50–72	C2g	99	22
Wadena loam:						
SW¼NE¼ sec. 13, T. 121 N., R. 25 W. (Modal profile.)	Outwash plain of Mississippi River.	180	0–7	Alp	99	19
		181	13–18	B21	113	14
		182	40–49	C3	107	17
SW¼NE¼ sec. 13, T. 119 N., R. 28 W. (Maximal profile.)	Outwash plain of Crow River.	183	0–8	Ap	91	24
		184	15–21	B21	98	22
		185	42–60	C2	104	16
NW¼NE¼ sec. 4, T. 118 N., R. 28 W. (Minimal profile.)	Outwash terrace of Sucker Creek.	177	0–8	Alp	106	16
		178	18–24	B22	111	14
		179	56–68	C2	102	17
Webster silty clay loam:						
NW¼NW¼ sec. 27, T. 118 N., R. 26 W. (Modal profile.)	Till on ground moraine (Mankato age).	174	0–8	Alp	79	31
		175	13–18	B21g	93	25
		176	24–48	Cg	107	18
SW¼SE¼ sec. 34, T. 118 N., R. 26 W. (Maximal profile.)	Till on ground moraine (Mankato age).	168	0–8	A1	79	32
		169	16–28	B22g	85	29
		170	28–48	Cg	106	17
Webster silt loam:						
NW¼NE¼ sec. 35, T. 121 N., R. 24 W. (Minimal profile.)	Till on ground moraine (Mankato age).	171	0–7	Alp	75	36
		172	13–19	B21g	105	16
		173	31–50	C2g	109	16

[1] Based on AASHO Designation: T 99–57, Method C (*1*).

[2] Mechanical analysis according to AASHO Designation: T 88–57 (*1*). Results by this procedure frequently may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for naming textural classes for soils.

a soil material is in a plastic condition. A nonplastic soil is a soil that is granular or without cohesion. For such soils the liquid limit or plastic limit cannot be determined.

Engineering descriptions of the soils

In table 6 the soils of the county and their map symbols are listed and certain characteristics that are significant to engineering are described. The estimated classification according to the AASHO and the Unified classification systems is given for each important layer. These estimates are based on soil test data in table 5, on information in the rest of the report, and on experience with similar soils in this and in other counties.

Depth to the water table, as shown in table 6, is based on field observations.

Permeability of the soil as it occurs in place was estimated. The estimates are based on the structure and

test data

Public Roads (BPR), in accordance with Standard Procedures of the American Association of State Highway Officials (AASHO)]

Mechanical analysis [2]									Liquid limit	Plasticity index	Classification	
Percentage passing sieve—					Percentage smaller than—							
3/4 in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.			AASHO	Unified [3]
		100	89	78	74	52	21	12	52	6	A-5(10)	MH.
	100	99	98	94	89	72	51	44	70	38	A-7-5(20)	MH-CH.
100	96	93	82	51	42	30	16	13	26	6	A-4(3)	ML-CL.
		100	97	90	76	57	23	16	25	2	A-4(8)	ML.
	100	97	96	95	89	75	58	49	66	31	A-7-5(20)	MH.
			100	99	93	83	54	38	57	28	A-7-6(19)	MH-CH.
		100	96	80	74	56	27	17	52	10	A-5(10)	MH.
100	99	97	93	75	70	61	47	39	58	28	A-7-5(19)	MH-CH.
100	98	92	84	60	48	40	26	20	43	17	A-7-6(8)	ML-CL.
		100	80	47	43	33	16	11	37	9	A-4(2)	SM.
	100	98	80	46	41	27	14	10	30	10	A-4(2)	SC.
[4] 98	86	74	39	4					(5)	(5)	A-1-b(0)	SP.
		100	94	69	63	50	28	15	44	13	A-7-5(9)	ML.
		100	96	71	65	54	37	28	39	14	A-6(9)	ML-CL.
100	98	94	70	3					(5)	(5)	A-3(0)	SP.
100	99	98	84	37	31	24	12	7	27	4	A-4(0)	SM-SC.
	100	99	88	48	40	30	15	12	26	6	A-4(3)	SM-SC.
100	98	96	88	6					(5)	(5)	A-3(0)	SP-SM.
	100	99	93	75	70	54	34	25	57	18	A-7-5(15)	MH.
100	99	97	90	70	64	51	37	29	57	30	A-7-6(18)	CH.
100	94	86	71	44	37	26	16	13	36	13	A-6(3)	SM-SC.
	100	99	91	81	77	64	33	22	56	16	A-7-5(14)	MH.
	100	99	97	94	91	86	69	47	72	36	A-7-5(20)	MH.
100	98	96	86	59	46	38	24	19	34	13	A-6(6)	CL.
100	98	97	86	64	60	48	23	13	57	11	A-7-5(9)	MH.
	100	98	85	52	46	35	25	18	39	19	A-6(7)	CL.
100	98	95	85	53	47	34	17	13	35	14	A-6(5)	CL.

[3] SCS and BPR have agreed to consider that all soils having plasticity indexes within two points from A-line are to be given a borderline classification. Examples of borderline classifications obtained by this use are MH-CH, ML-CL, SP-SM, and SM-SC.
[4] The amount of material passing the 1½ inch sieve was 100 percent.
[5] Nonplastic.

consistence of the soil material and on field observations.

Available water capacity, given in inches per inch of soil depth, refers to the approximate amount of capillary water in the soil when the soil is wet to field capacity. When the soil is air dry, this same amount of water will wet the soil material to a depth of 1 inch without deeper percolation. Data are needed on representative soils from undisturbed soil samples or from field measurements if reliable estimates are to be made.

The shrink-swell potential is an indication of the volume change to be expected of the soil material with the change in moisture content. It is estimated on the basis of the amount and type of clay in the soil layers. In general soils classified as A-7 and CH have high shrink-swell potential. Clean sands and gravels and those having a small amount of nonplastic to slightly plastic fines have low shrink-swell potential, as does most other nonplastic to slightly plastic soil material.

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TABLE 6.—*Engineering description of the soils and their*

[Absence of figures indicates information

Soil series, land types, and map symbols	Depth to water table	Depth from surface	Classification
			USDA texture
	Feet	*Inches*	
Alluvial land (Al)	(2)	(2)	(2)
Ames	2–4	0–7	Silt loam
		7–10	Silt loam
(Mapped only with soils of the Dundas series.)		10–30	Silty clay or clay
		30–48	Clay loam
Anoka	10+	0–8	Loamy fine sand
		8–20	Loamy fine sand
(Mapped only with soils of the Braham series.)		20–40	Fine sand, loamy fine sand, and sandy loam in variable layers.
Beach materials, sandy (Ba)	0–4	(2)	(2)
Becker (Bb)[3]	3–6	0–12	Loam
		12–28	Loam to sandy loam
		28–48	Sand
Biscay (Bc)[3]	1–3	0–14	Loam
		14–34	Loam or sandy loam
		34–48	Sand and gravel
Biscay, sandy subsoil variant (Bd)[3]	2–5	0–10	Loam
		10–16	Sandy loam to loamy sand
		16–48	Sand and gravel
Blue Earth (Be)[4]	0–3	0–20	Silt loam
		20–48	Silty clay loam
Braham (BhB2, BhC2, BhD, BrA, BrB, BrC)	10+	0–8	Loamy fine sand
		8–32	Fine sand
(For properties of Anoka soil in all these mapping units, refer to Anoka series in this table.)		32–48	Sandy loam or clay loam
Burnsville (BuB, BuB2, BuC, BuC2, BuC3, BuD, BuD3, BuE, ByB, ByB2, ByC, ByC2, ByD, ByE).	10+	0–8	Sandy loam or loam
		8–18	Loam or clay loam
(For properties of Hayden soils in mapping units ByB through ByE, refer to Hayden series in this table.)		18–48	Gravel and sand
Canisteo (Ca)[3]	1–4	0–15	Silty clay loam
		15–27	Silty clay loam
		27–48	Clay loam
Chelsea (ChB, ChC, ChD)	10+	0–7	Fine sand
		7–48	Fine sand
Clayey basin land (Cn)[3]	0–3	(2)	(2)
Comfrey (Co, Cp)[3]	2–5	0–18	Silty clay loam
		18–30	Silty clay loam
		30–48	Silty clay loam or silt loam
Cordova (Cs, Cw)[3]	2–3	0–10	Silty clay loam
		10–28	Silty clay
(For properties of Le Sueur soil and of Webster soil in mapping units Cs and Cw, refer to Le Sueur series and Webster series, respectively, in this table.)		28–48	Clay loam
Duelm (De)	2½–3½	0–14	Sandy loam
		14–20	Sandy loam
(For properties of Watseka soil in mapping unit De, refer to Watseka series in this table.)		20–26	Loamy sand
		26–48	Sand

See footnotes at end of table.

estimated properties significant to engineering

was not available or was not obtained]

Classification—Continued		Percentage passing sieve—			Permeability [1]	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 4	No. 10	No. 200				
					Inches per hour	*Inches per inch of soil*	*pH value*	
(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	Low to moderate.
ML	A-4	100	100	70–85	0. 3	0. 18	5. 6–7. 3	Low.
ML	A-4	100	100	70–85	0. 20–0. 63	. 18	5. 1–6. 5	Low.
CH	A-7	100	95–100	80–95	0. 05–0. 20	. 17	4. 6–6. 0	High.
CL	A-6 or A-7	95–100	90–95	55–75	0. 63–2. 0	. 16	7. 4–7. 8	Moderate to high.
SM	A-2	100	100	15–30	6. 30+	. 07	5. 1–6. 0	Low.
SM	A-2	100	100	10–20	6. 30+	. 05	5. 1–6. 0	Low.
SP, SM in variable layers.	A-2, A-3 in variable layers.	(2)	(2)	(2)	(2)	(2)	5. 1–6. 0	Low.
(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2).
OL or ML	A-4	100	100	50–65	0. 6	. 18	5. 6–7. 3	Low.
ML or SM	A-4	100	100	40–55	2. 0–6. 30	. 15	5. 6–7. 3	Low.
SP–SM or SM	A-2 or A-3	100	95–100	5–15	6. 30+	. 04	6. 5–7. 3	Low.
ML or ML–CL	A-4	95–100	90–100	50–65	0. 5	. 2	6. 6–7. 8	Low to moderate.
CL or SC	A-4 or A-6	95–100	90–100	35–65	0. 63–2. 0	. 16	6. 6–7. 8	Low to moderate.
SP or GP	A-1 or A-2	50–80	45–70	2–5	6. 30+	. 01	7. 4–7. 8	Low.
SM	A-2	90–100	90–100	25–35	0. 6	. 2	6. 1–7. 3	Low to moderate.
SM	A-2	90–100	80–90	20–30	6. 30+	. 11	6. 1–7. 3	Low.
SP or GP	A-1	45–70	30–40	2–5	6. 30+	. 01	6. 5–7. 3	Low.
OL	A-5	95–100	95–100	70–90	1. 0	. 25	7. 4–7. 8	Low.
ML or MH	A-7	95–100	95–100	80–90	0. 63–2. 0	. 20	7. 4–7. 8	Moderate to high.
SM	A-2	100	100	15–30	6. 30+	. 07	5. 1–6. 0	Low.
SP–SM or SM	A-2	100	100	10–20	6. 30+	. 03	5. 1–6. 0	Low.
SM, CL, or ML–CL	A-4 or A-6	95–100	90–100	60–75	0. 63–2. 0	. 16	5. 6–7. 8	Moderate.
SM or ML	A-4	95–100	85–95	35–60	0. 6–1. 3	. 13	5. 6–6. 5	Low.
ML–CL or CL	A-6	70–80	85–95	50–70	2. 0–6. 3	. 15	5. 1–6. 5	Low.
GW	A-1	30–50	20–30	2–5	6. 30+	. 02	7. 4–7. 8	Low.
OH or M–H	A-7	95–100	95–100	65–80	0. 4	. 20	7. 4–7. 8	Moderate to high.
CL	A-7	95–100	95–100	65–80	0. 20–0. 63	. 18	7. 4–7. 8	Moderate to high.
CL	A-6 or A-7	95–100	95–100	60–75	0. 32–2. 0	. 17	7. 4–7. 8	Moderate to high.
SP–SM or SM	A-2	100	100	10–20	1. 0	. 04	5. 1–6. 0	Low.
SP–SM or SM	A-2	100	100	10–20	6. 30+	. 04	5. 1–6. 0	Low.
(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	High.
MH	A-7	100	100	80–90	0. 4	. 20	6. 1–7. 8	Moderate to high.
CL	A-7	100	100	80–90	0. 20–0. 63	. 18	6. 6–7. 8	Moderate to high.
CL or ML–CL	A-7	100	100	70–85	0. 20–2. 0	. 18	7. 4–7. 8	Moderate.
MH	A-7	100	100	70–85	0. 4	. 20	6. 1–7. 3	Moderate to high.
CH	A-7	100	100	70–85	0. 20–0. 63	. 18	5. 1–6. 5	High.
CL	A-7 or A-6	95–100	90–100	50–70	0. 63–2. 0	. 17	7. 4–7. 8	Moderate to high.
SM	A-2	95–100	85–95	20–35	0. 7	. 14	5. 6–7. 3	Low.
SM	A-2	95–100	80–90	20–30	2. 0–6. 30	. 06	5. 6–7. 3	Low.
SM	A-2	95–100	80–90	15–25	6. 30+	. 04	5. 6–7. 3	Low.
SP–SM	A-3	85–95	80–95	5–10	6. 30+	. 03	5. 6–7. 3	Low.

TABLE 6.—*Engineering description of the soils and their*

Soil series, land types, and map symbols	Depth to water table	Depth from surface	Classification
			USDA texture
	Feet	*Inches*	
Dundas (Dn, Du)	2–4	0–7	Silt loam
		7–35	Silty clay
(For properties of Ames soil in mapping unit Du, refer to Ames series in this table.)		35–48	Clay loam
Emmert (EmB, EmC, EmD, EmE)	10+	0–7	Sandy loam
		7–17	Loamy sand
(For properties of Milaca soil in all these mapping units, refer to Milaca series in this table.)		17–48	Gravel and sand
Estherville:			
Loams (EsA, EsB, EsB2, EsC, EsC2)	10+	0–9	Loam
		9–21	Loam
		21–48	Gravel and sand
Sandy loams (EtA, EtB, EtB2, EtC, EtC2, EtD, EtE, EvC3, EvE3).	10+	0–9	Sandy loam
		9–19	Sandy loam or loam
		19–48	Gravel and sand
Fairhaven (FaA, FaB, FaB2, FaC2)	10+	0–9	Silt loam
		9–24	Silt loam or silty clay loam
		24–48	Gravel and sand
Glencoe (Gc) [4]	0–3	0–21	Silty clay loam
		21–36	Silty clay loam
		36–48	Clay loam
Guckeen (GuA, GuB, GuC) [3]	4–8	0–12	Silty clay loam
		12–48	Silty clay
		48–60	Silty clay loam
Hayden:			
Fine sandy loams (HdA, HdB, HdB2, HdC, HdC2, HdD, HdD2).	10+	0–12	Sandy loam
		12–18	Sandy loam or loam
		18–36	Clay loam
		36–48	Loam or clay loam
Loams (HlB, HlB2, HlC, HlC2, HlD, HlD2, HlE, HlF); clay loams (HaC3, HaD3); soils (HnE3).	10+	0–7	Loam
		7–10	Loam
		10–30	Clay loam
		30–48	Clay loam
Hubbard:			
Loamy sands (HrA, HrB, HrB2, HrC, HrC2, HrE2)	10+	0–9	Loamy sand
		9–16	Loamy sand
		16–48	Sand
Sandy loams (HuA, HuA2, HuB, HuB2, HuC, HuC2)	10+	0–10	Sandy loam
		10–21	Sandy loam
		21–48	Sand
Hubbard, gravelly subsoil variants (HsA, HsB, HsB2, HsC)	10+	0–8	Loamy sand
		8–18	Loamy sand
		18–48	Sand and gravel
Lake borders (Lb)	(2)	(2)	(2)
Lester (LcC3, LcD3, LcE3, LeB, LeB2, LeC, LeC2, LeD, LeE, LeF, LtB, LtB2, LtC, LtD).	10+	0–9	Loam
		9–39	Clay loam
(For properties of Estherville soils in mapping units LtB through LtD, refer to Estherville series in this table.)		39–48	Clay loam
Lester, silty variants (LrA, LrB, LrB2, LrC2)	10+	0–10	Silt loam
		10–24	Silty clay loam
		24–48	Silt loam

See footnotes at end of table.

estimated properties significant to engineering—Continued

Classification—Continued		Percentage passing sieve—			Permeability [1]	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 4	No. 10	No. 200				
					Inches per hour	*Inches per inch of soil*	*pH value*	
MH or O–H	A–5	100	100	70–90	0. 3	0. 20	5. 6–7. 3	Low.
MH–CH or CH	A–7	100	95–100	80–90	0. 20–0. 63	. 18	4. 6–6. 5	High.
ML–CL or CL	A–6 or A–7	95–100	90–95	55–75	0. 63–2. 0	. 16	7. 4–7. 8	Moderate to high.
SM	A–2	95–100	70–80	15–25	1. 0	. 10	5. 6–6. 5	Low.
SM	A–2	95–100	55–70	10–20	6. 30+	. 06	5. 6–6. 5	Low.
GW, GP	A–1	30–50	20–35	2–5	6. 30+	. 02	5. 6–6. 5	Low.
ML	A–4	80–90	80–90	55–70	0. 6	. 15	5. 6–6. 5	Low.
ML	A–4	80–90	80–90	55–70	2. 0–6. 30	. 15	5. 6–6. 5	Low.
GW or GP	A–1	25–50	25–40	2–5	6. 30+	. 02	7. 4–7. 8	Low.
SM	A–2 or A–4	95–100	70–80	25–50	0. 7	. 12	5. 6–6. 5	Low.
SM, SC or ML	A–2 or A–4	90–95	75–85	30–60	2. 0–6. 30	. 10	5. 6–6. 5	Low.
GW, GP or SP	A–1	35–55	25–40	2–5	6. 30+	. 02	7. 4–7. 8	Low.
ML or ML–CL	A–4	100	95–100	70–85	0. 6	. 20	6. 1–7. 3	Low.
ML or CL	A–4 or A–6	100	95–100	70–90	2. 0 –6. 30+	. 18	5. 6–6. 5	Low to moderate.
GP–GM or SP	A–1	35–60	25–40	2–10	6. 30+	. 01	7. 4–7. 8	Low.
MH	A–7	100	100	80–90	0. 4	. 25	6. 1–7. 8	Moderate to high.
MH–CH	A–7	100	100	80–90	0. 20–0. 63	. 20	6. 1–7. 8	Moderate to high.
CL	A–7	90–100	90–100	65–80	0. 63–2. 0	. 17	7. 4–7. 8	Moderate to high.
MH	A–7	100	100	85–95	0. 4	. 19	6. 1–7. 3	High.
CH	A–7	100	100	90–95	0. 20–0. 63	. 17	6. 1–7. 3	High.
CL	A–7	100	100	85–95	0. 63–2. 0	. 17	7. 4–7. 8	Moderate to high.
SM	A–4 or A–2	100	95–100	20–45	0. 5	. 15	5. 6–6. 5	Low.
SM or ML–CL	A–4 or A–6	100	95–100	35–70	0. 63–2. 0	. 16	5. 6–6. 5	Low.
CL	A–6	100	95–100	60–80	0. 63–2. 0	. 16	5. 6–6. 5	Moderate.
ML–CL or CL	A–6	90–100	90–100	60–75	0. 63–2. 0	. 16	7. 4–7. 8	Moderate.
ML–CL	A–4	100	95–100	50–70	0. 3	. 17	6. 1–6. 5	Low.
ML–CL	A–4	100	95–100	50–70	0. 63–2. 0	. 17	6. 1–6. 5	Low.
CL	A–7	100	95–100	65–85	0. 63–2. 0	. 17	5. 1–6. 5	Moderate to high.
CL or ML–CL	A–6	95–100	95–100	60–75	0. 63–2. 0	. 17	7. 4–7. 8	Moderate.
SM	A–2	100	95–100	15–25	1. 0	. 06	5. 1–6. 0	Low.
SM	A–2	100	95–100	15–20	6. 30	. 04	5. 1–6. 0	Low.
SP–SM	A–2 or A–3	100	95–100	5–10	6. 30+	. 02	5. 1–6. 0	Low.
SM	A–2	100	90–100	25–35	0. 8	. 13	5. 6–6. 5	Low.
SM	A–2	100	85–95	25–35	6. 30+	. 13	5. 6–6. 5	Low.
SP	A–2 or A–3	100	85–95	0–5	6. 30+	. 03	5. 6–6. 5	Low.
SM	A–2	100	90–100	15–25	1. 0	. 06	5. 6–6. 0	Low.
SM	A–2	90–100	90–100	10–20	6. 30+	. 04	5. 6–6. 0	Low.
SP	A–1 or A–2	60–80	40–60	0–5	6. 30+	. 02	6. 1–7. 8	Low.
(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2).
ML	A–6	95–100	95–100	55–75	0. 5	. 19	6. 1–7. 3	Moderate.
CL	A–6 or A–7	95–100	95–100	65–80	0. 63–2. 0	. 18	5. 1–6. 5	Moderate to high.
CL or ML–CL	A–6	95–100	95–100	60–70	0. 63–2. 0	. 17	7. 4–7. 8	Moderate.
ML–CL	A–4	100	100	75–85	0. 5	. 20	6. 1–7. 3	Low.
CL or ML–CL	A–6	100	100	80–90	0. 63–2. 0	. 19	5. 6–6. 5	Moderate.
ML–CL or ML	A–4	100	100	75–85	0. 63–2. 0	. 19	7. 4–7. 8	Low.

TABLE 6.—*Engineering description of the soils and their*

Soil series, land types, and map symbols	Depth to water table	Depth from surface	Classification
			USDA texture
	Feet	*Inches*	
Le Sueur (LuA, LuB)[3]	4–8	0–11	Clay loam
		11–32	Clay loam
		32–48	Clay loam
Marna (Ma)[3]	2–3	0–10	Silty clay loam
		10–30	Silty clay
		30–48	Clay loam or silty clay loam
Marsh (Mh) (Classification not established).[4]			
Milaca (MlB2)	(2)	(2)	(2)
Muck (Mu)[4]	0–3		Muck
Nessel (NeA, NeB)	4–8	0–3	Silt loam
		3–7	Loam
		7–35	Clay loam
		35–48	Clay loam or loam
Peat and muck (Pa, Pm, Ps)[4]	0–3		Peat or muck
Rasset (RhA, RhB, RhB2, RhC, RhC2) (For properties of Hubbard soils in all these mapping units, refer to Hubbard series in this table.)	4–8	0–9	Loamy sand or sandy loam
		9–19	Sandy loam
		19–42	Sand with layers of loamy sand and sandy clay loam.
Salida:			
Gravelly sandy loams (SaB, SaC, SaE)	10+	0–10	Gravelly sandy loam
		10–48	Gravel and sand
Complexes (ScB, ScC, ScE)	10+	0–7	Gravelly sandy loam
		7–42	Gravel and sand
Sattre, silty variants (SeA, SeB)	10+	0–8	Silt loam
		8–32	Silt loam or silty clay loam
		32–48	Gravel and sand
Storden (SlC2, SlD2, SlE2, StC3, StD3) (For properties of Lester soil in all these mapping units, refer to Lester series in this table.)	10+	0–7	Loam
		7–48	Loam
Talcot (Tc)[4]	0–3	0–24	Silty clay loam or clay loam
		24–32	Sandy clay loam
		32–48	Gravel and sand
Terril:			
Loam, occasionally flooded (TeA)[3]	4–8	0–28	Loam
		28–48	Loam
Loam, sandy substratum (TlA)[3]	5–10	0–48	Loam
		48–60	Sand and gravel
Undifferentiated—Terril soils (TsB)[3]	4–8	0–24	Loam
		24–48	Loam
Wadena (WaA, WaB, WaB2, WaC2)	10+	0–10	Loam
		10–25	Loam or sandy loam
		25–48	Sand and gravel
Watseka (Mapped only with soils of the Duelm series.)	2½–3½	0–12	Loamy sand
		12–16	Loamy sand
		16–48	Sand

See footnotes at end of table.

estimated properties significant to engineering—Continued

Classification—Continued		Percentage passing sieve—			Permeability [1]	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 4	No. 10	No. 200				
					Inches per hour	*Inches per inch of soil*	*pH value*	
OL or CL	A–7	100	95–100	65–80	0. 5	0. 20	5. 6–6. 1	Moderate.
CL	A–7	95–100	90–95	70–80	0. 63–2. 0	. 18	5. 6–6. 5	Moderate to high.
CL or ML–CL	A–6	95–100	90–95	60–75	0. 63–2. 0	. 17	7. 5	Moderate.
MH	A–7	100	95–100	85–90	0. 4	. 20	5. 6–7. 3	High.
CH or MH	A–7	100	95–100	85–95	0. 20–0. 63	. 17	5. 6–7. 8	High.
CL	A–6 or A–7	100	90–100	60–75	0. 63–2. 0	. 17	7. 4–7. 8	Moderate to high.
[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2].
OH or OL					1. 0	. 50		Low to moderate.
ML	A–4	100	100	70–90	0. 3	. 20	6. 1–6. 5	Low.
ML–CL	A–4	100	100	70–90	0. 20–0. 63	. 18	6. 1–6. 5	Low.
CH or CL	A–7	100	95–100	70–90	0. 63–2. 0	. 17	5. 1–6. 0	High.
ML–CL or CL	A–7 or A–6	100	95–100	65–80	2. 0–6. 30	. 16	7. 4–7. 8	Moderate.
Pt					[2]	. 5		
SM	A–2	95–100	95–100	15–30	1. 0	. 08	5. 1–7. 3	Low.
SM	A–2	95–100	95–100	20–35	2. 0–6. 30	. 08	5. 1–7. 3	Low.
SP–SM with layers of SM and SC.	A–2	95–100	75–95	5–25	6. 30+	. 03	5. 1–7. 3	Low.
SM	A–2 or A–1	80–90	65–80	10–20	1. 0	. 04	6. 1–7. 3	Low.
GW, GP or SP	A–1	35–60	25–40	2–5	6. 30+	. 02	7. 4–7. 8	Low.
SM	A–2 or A–1	75–90	50–75	10–20	1. 0	. 07	5. 6–7. 3	Low.
GW, GP or SP	A–1	35–60	30–40	2–5	6. 30+	. 01	7. 4–7. 8	Low.
ML–CL	A–4	100	100	70–85	0. 6	. 19	6. 1–6. 5	Low to moderate.
ML–CL or CL	A–4 or A–6	100	100	70–85	2. 0–6. 30	. 19	5. 6–6. 5	Low to moderate.
GW, GP or SP	A–1	35–65	35–50	2–5	6. 30+	. 01	7. 4–7. 8	Low.
ML	A–4	95–100	95–100	55–70	0. 15	. 16	7. 4–7. 8	Moderate.
ML–CL	A–6	95–100	85–95	55–70	0. 63–2. 0	. 16	7. 4–7. 8	Moderate.
MH	A–7	100	100	65–80	0. 4	. 20	7. 4–7. 8	Moderate to high.
CL	A–6	100	85–95	40–55	0. 2–0. 63	. 16	7. 4–7. 8	Moderate.
GP–GM or SP–SM	A–1 or A–2	35–65	30–45	5–10	6. 30+	. 04	7. 4–7. 8	Low.
ML or ML–OL	A–4 or A–5	100	95–100	55–75	0. 5	. 20	5. 6–7. 3	Low to moderate.
ML	A–4	100	95–100	55–70	0. 63–2. 0			
ML or ML–OL	A–4 or A–5	100	90–100	55–75	0. 5	. 20	5. 6–6. 5	Low to moderate.
SP–SM or GP–GM	A–1 or A–2	100	90–100	0–5	6. 30+	. 03	6. 1–7. 8	Low.
ML–OL or ML	A–4, A–5	100	90–100	55–75	0. 5	. 20	6. 1–7. 3	Low to moderate.
ML	A–4	100	90–100	55–70	0. 63–2. 0	. 20	6. 5–7. 3	Moderate.
ML	A–4	100	95–100	50–65	0. 6	. 17	6. 1–7. 3	Low.
ML–CL or SM–SC	A–4	100	95–100	40–60	2. 0–6. 30	. 15	5. 6–6. 5	Low.
GP, GW or SP	A–1 or A–3	40–60	30–40	2–5	6. 30+	. 02	7. 4–7. 8	Low.
SM	A–2	85–95	85–95	20–30	1. 0	. 10	5. 6–7. 3	Low.
SM	A–2	85–95	80–90	12–25	6. 30+	. 06	5. 6–7. 3	Low.
SP–SM	A–2 or A–1	80–95	30–60	5–10	6. 30+	. 03	5. 6–7. 3	Low.

TABLE 6.—*Engineering description of the soils and their*

Soil series, land types, and map symbols	Depth to water table	Depth from surface	Classification
			USDA texture
	Feet	*Inches*	
Webster [3]	2–2½	0–13	Silty clay loam
(Mapped only with soils of the Cordova series.)		13–24	Clay loam
		24–48	Clay loam
Webster, silty variant (We) [3]	2–3	0–16	Silty clay loam
		16–26	Silty clay loam
		26–48	Silt loam

[1] The rate given for the surface layer is that of infiltration into the uneroded surface soil; for eroded soils the rate is about one-third less; for horizons beneath the surface layers, the rate in inches per hour expresses the permeability of the horizon. Classes of permeability are as follows:

	Inches per hour
Slow	0–0. 20
Moderately slow	0. 2–0. 63
Moderate	0. 63–2. 0
Moderately rapid	2. 0–6. 30
Rapid	6. 30+

Engineering interpretations

Table 7 rates the soils according to their suitability as a source of topsoil, sand, gravel, and road fill. It also gives soil features that affect the suitability of the soils as sites for highways and for agricultural engineering. The information is based partly on estimates. It is also based on data obtained by testing soils from this county and partly on data for similar soils from other counties. Some soil features mentioned in the table may be helpful in one kind of engineering work and a hindrance in another. For example, a rapidly permeable substratum makes a soil unsuitable as a site for a farm pond, but the soil may be favorable for artificial drainage. One main feature considered in rating the suitability of the soils for various purposes was susceptibility to frost heaving.

The susceptibility of the soils to frost action affects the amount of earthwork that can be done in winter. It may be desirable to suspend earthwork in winter to avoid the use of frozen soil material, though this is not always economically feasible. Earthwork can normally be done in winter in gravelly and sandy material that contains only a small amount of silt or clay if frozen material is excluded and standards for compaction of the soil are maintained.

In rating the soils as a source of sand or gravel, the susceptibility of the soil material to frost action was considered. Soils that consist of a mixture of clay, silt, and coarser textured material are less susceptible to frost heaving and subsequent frost boils than soils that contain a large amount of silt or very fine sand. A soil is susceptible to damaging frost action if about 10 percent or more of the soil material passes a No. 200 sieve.

Use of soil material that is uniform is important in earthwork because damage from frost heaving results where there are differences in expansion between one material and another. Some deposits of glacial till contain lenses or pockets of fine sand and silt that cause differential frost heave. If the subgrade for a highway is laid over glacial till, it should contain a thick enough layer of material that is not susceptible to frost heave so that the pavement will not be damaged when freezing occurs.

At many construction sites major variations may occur within the depth of the proposed excavation, and several different kinds of soils may occur within a short distance. In the uplands in this county there are many wet areas in which the material is largely organic. Some of the areas consist of peat and muck that in places is 20 feet or more thick. Organic material has low bearing strength and is therefore not suitable for use in foundations for roads or other engineering structures. The organic material should be removed and replaced with more suitable material, if feasible, or if the deposits are too deep for removal, use of the areas ought to be avoided.

In depressions throughout the county, the water table is normally high. In these areas the embankments of highways ought to be constructed high enough that the surface of the pavement is at least 4 feet above the highest point reached by the water table. Before engineering structures are planned for depressional areas, each area should be thoroughly investigated.

If a highway is to be located where the water table is high, drainage ditches should be constructed before earthwork is started. The ditches make the soils more suitable for borrow material and for roadway excavation. Underdrains may be required where either a perched water table or a normal water table might cause the soil to be unstable.

Soils and Community Developments

This section has two parts. The first discusses the soils and their use for building sites, and the second describes uses of the soils for various kinds of recreation.

Wright County is near Minneapolis, and its population, particularly in the eastern part, is increasing steadily because the suburbs of Minneapolis are steadily expanding into areas formerly used for farming. Consequently the demand for shopping centers, schools,

estimated properties significant to engineering—Continued

Classification—Continued		Percentage passing sieve—			Permeability [1]	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 4	No. 10	No. 200				
					Inches per hour	*Inches per inch of soil*	*pH value*	
MH	A–7	100	95–100	65–80	0. 4	0. 20	6. 5–7. 3	Moderate to high.
CL or CH	A–7	100	95–100	65–80	0. 20–0. 63	. 18	6. 5–7. 8	Moderate to high.
CL	A–7 or A–6	100	90–95	50–70	0. 63–2. 0	. 17	7. 4–7. 8	Moderate.
MH	A–7	100	100	80–90	0. 4	. 20	6. 6–7. 8	Moderate to high.
CL or MH	A–6 or A–7	100	100	80–90	0. 20–0. 63	. 20	6. 6–7. 8	Moderate.
CL	A–6	100	100	70–80	0. 63–2. 0	. 20	7. 4–7. 8	Moderate.

[2] Variable.

[3] High content of organic matter; in these soils the upper layers are 5 to 8 percent organic matter, but the content decreases with increasing depth.

[4] Very high content of organic matter; in these soils the upper layers are more than 8 percent organic matter, but the content decreases with increasing depth.

parks, golf courses, and other developments is also increasing.

In selecting a site for a home, a highway, or for industrial purposes, the suitability of the soils in each site for such use must be considered. Soils that are nearly level to gently sloping, deep, and well drained and that are fairly free of stones and boulders generally provide the best sites. Of paramount importance, however, is the suitability of the soils for septic tank filter fields.

Septic tank filter fields.—Most community developments in this county are in areas beyond existing sewerage lines, and the use of septic tanks is necessary. Areas selected for homes, factories, or other community developments must therefore be suitable for septic tanks. Each site must be examined closely to determine the ability of the soil to absorb and filter the effluent that flows from the septic tank (*18*).

Some soils absorb effluent rapidly; others absorb it slowly. How satisfactorily a sewage disposal system works depends largely on the absorption ability of the soil, since the effluent from the septic tank must be absorbed and filtered by the soil. Soils that have a slow rate of absorption require a larger field than those that have a rapid rate. Thus the size of the lot needed for a particular building depends on the kind of soil.

Studies show that some septic tanks fail because they are installed in poorly drained soils that are dense, compact, and fine textured. The percolation of water through such soils in wet weather and for a long period afterwards is hindered because the soils are saturated and lack space for absorption of septic tank effluent. Other causes for failure of septic tanks are a seasonal high water table, flooding by overflow from streams, shallowness to bedrock or a cemented substratum, and slopes of more than 10 percent.

The soil map in the back of this soil survey is reliable for predicting the general suitability of an area of several acres, but it may not contain sufficient detail to predict the suitability for a specific site. Soil variations may occur within a short distance, and most maps are not detailed enough to supply the precise information as to where on a building site a filter field should be located. Therefore, onsite evaluation by a soil scientist or measurements of the rate of water movement may be needed. The rate of water movement is measured by a percolation test. A percolation test will not only indicate whether the soil is suitable but will also provide the information needed to calculate the size of the filter field.

Soil groups for building sites

The soils of Wright County have been placed in 11 groups on the basis of characteristics that affect their use for residential or commercial construction. The main characteristics considered are drainage, freedom from flooding, depth of the soil, percent of slope, texture of the substratum, and stoniness. The soils in any one group are similar in those characteristics that affect their suitability for residences and community developments. The names of the soils in any group can be learned by referring to the "Guide to Mapping Units" at the back of this publication.

The grouping of soils for building sites, with information given in "Engineering Uses of the Soils" and "Descriptions of the Soils," along with maps at the back of this report, will aid those seeking suitable building sites. The groupings, however, are not a substitute for the detailed investigations needed at the place proposed for a building site. Also the groupings take into account only the characteristics of the soils to a depth of 5 feet, though certain predictions can be made for the soil beyond this depth. Not considered are distances to established centers, transportation lines, and other economic factors.

In the discussion of each building site group, the soils in that group are rated as very good, good, fair, poor, and very poor as building sites, according to the limitations of the soils. *Very good* means that there are few or no limitations to use, and *good* means that limitations are slight and easy to overcome. A rating of *fair* means limitations are moderate, but the soils can be used under

TABLE 7.—*Engineering interpretations*

Soil series and map symbol	Suitability as a source of—				Soil features affecting highway location
	Topsoil [1]	Sand	Gravel	Road fill [2]	
Alluvial land (Al)	Variable; check each site.	Not suitable	Not suitable	Poor to fair; check each site.	Moderate to high susceptibility to frost action; subject to frequent flooding.
Ames (Mapped only with soils of the Dundas series.)	Fair to a depth of about 10 inches.	Not suitable	Not suitable	Very poor to a depth below 3 feet; fair to poor in substratum; high water content in places.	Fairly high water table; plastic, clayey subsoil; poor stability; low bearing capacity.
Anoka (Mapped only with soils of the Braham series.)	Fair to poor	Fair; poorly graded fine sand and thin layers of sandy loam or loam; not suitable for concrete.	Not suitable	Fair to good; fair to good shear strength; good compaction characteristics; very low compressibility.	Good drainage; low susceptibility to frost action; good bearing capacity; erodes easily if exposed on embankments.
Beach materials, sandy (Ba)	Not suitable	Not suitable	Poor to good; check each site.	Poor to good; check each site.	Moderate susceptibility to frost action; high water table.
Becker (Bb)	Good to a depth of several feet.	Good but has 3 to 4 feet of overburden; material below is poorly graded sand that is 5 to 15 percent fines.	Not suitable	Fair to poor in upper 3 feet, good below; subject to occasional flooding; seasonal high water table.	Seasonal high water table; subject to occasional flooding; moderate to high susceptibility to frost action.
Biscay (Bc)	Good to a depth of 12 to 18 inches.	Fair to good below a depth of 3 feet; stratified layers of coarse sand and of coarse sand and gravel; wash for concrete.	Generally not suitable; gravel too fine.	Good; good compaction characteristics and shear strength; high water table hinders excavation in places.	High content of organic matter to a depth of about 15 inches; high water table; good stability; moderate susceptibility to frost action; erodes if exposed on embankments.
Biscay, sandy subsoil variant (Bd)	Good to a depth of about 12 inches.	Fair to good below a depth of 2 feet; stratified layers of coarse sand and coarse sand and gravel.	Generally not suitable; gravel too fine.	Good; fair stability; low compressibility; good shear strength; low volume change; high water table hinders excavation in places.	High content of organic matter in the surface layer; high water table; moderate to low susceptibility to frost action; erodes if exposed on embankments.

See footnotes at end of table.

of soils in Wright County, Minnesota

Soil features affecting engineering practices						
Dikes or levees	Farm ponds [2]		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
	Reservoir area	Embankment				
Variable; check each site; poor to fair resistance to piping.	Subject to frequent flooding; high seepage rate.	Variable; check each site; poor resistance to piping.	Not needed	Suited in some areas if protected from flooding.	Not needed	Generally not needed.
Poor to fair stability; can be used for embankments with proper control.	High water table; suited to dugout ponds.	Fair to good stability in substratum; impervious when compacted; high water content in places.	Plastic soil and slow permeability limit success of tile for drainage.	Generally not used.	Not needed	Difficult to establish vegetation because of wetness and a plastic subsoil.
Poor to fair stability; fair to good compaction characteristics; moderate to rapid permeability when compacted.	Not suited; porous.	Poorly suited; pervious when compacted; poor resistance to piping; poor stability.	Not needed	Rapid intake rate; low water-holding capacity and fertility; undulating topography; subject to wind erosion.	Not needed; high intake rate; sandy and subject to wind erosion.	Difficult to establish in most places; subject to wind erosion.
Sandy; rapid seepage rate when compacted.	In some places suitable for dugout ponds.	Fair to good stability; poor to good resistance to piping; rapid permeability when compacted.	Not suited; nonagricultural land.	Not suited; nonagricultural land.	Not needed	Not needed.
Upper 3 feet has poor stability and poor resistance to piping, can be used in low dikes with proper control; substratum stable; pervious when compacted.	Not suited; porous susbtratum.	Poor stability in upper 3 feet; substratum stable, good compaction characteristics, and pervious when compacted.	Not needed	Moderate intake rate and water-holding capacity.	Not needed	Generally not needed.
Surface layer is high in organic matter; underlying material is fairly stable, has good compaction characteristics, and high permeability when compacted.	Fluctuating water table; suited to dugout ponds in level areas.	Fair stability; good compaction characteristics; piping is a hazard; pervious when compacted.	Needed; hazard of sloughing on side slopes of ditches; tile is difficult to install because trenches cave.	Generally not used; high water table; moderately high water-holding capacity; drainage needed.	Not needed	Not needed.
Fair stability; good compaction characteristics; rapid seepage rate when compacted.	Fluctuating water table; normally suited to dugout ponds; porous substratum.	Fair stability; good compaction characteristics; pervious when compacted; piping is a hazard.	Needed; tile not required; use shallow ditches that have wide bottoms; keep the water table at a depth of 30 to 42 inches.	Generally not used; high water table; high intake rate; moderate water-holding capacity; drainage needed.	Not needed	Wetness makes vegetation difficult to establish.

TABLE 7.—*Engineering interpretations*

Soil series and map symbol	Suitability as a source of—				Soil features affecting highway location
	Topsoil [1]	Sand	Gravel	Road fill [2]	
Blue Earth (Be)	Fair; very limy organic soil; needs special fertilizer treatments.	Not suitable	Not suitable	Poor; very high content of organic matter; high water table and water content.	High content of organic matter; high water table; high susceptibility to frost action; poor stability; low bearing strength.
Braham (BhB2, BhC2, BhD, BrA, BrB, BrC). (For properties of Anoka soils in all these mapping units, refer to Anoka series in this table.)	Poor	Poor; sand is less than 4 feet thick.	Not suitable	Good to a depth of 1 ½ to 4 feet; erodes easily; good shear strength and compaction characteristics; very low compressibility; underlying material is fair to good.	Good drainage; moderate susceptibility to frost action; good stability in upper 2 to 4 feet; highly erodible if exposed on embankments.
Burnsville (BuB, BuB2, BuC, BuC2, BuC3, BuD, BuD3, BuE, ByB, ByB2, ByC, ByC2, ByD, ByE). (For properties of Hayden soils in mapping units ByB through ByE, refer to Hayden series in this table.)	Fair to a depth of 6 to 10 inches.	Not suitable	Good, but gravel is mixed with sand; stones, boulders, and cobblestones occur in places.	Very good; excellent shear strength; good bearing capacity and stability.	Good drainage; good stability; low susceptibility to frost action; large boulders in some areas.
Canisteo (Ca)	Fair to good to a depth of 16 inches.	Not suitable	Not suitable	Poor in upper 2 feet because of high plasticity, but fair in substratum; fair stability; moderate to high volume change.	High content of organic matter in surface layer; high water table; poor bearing strength.
Chelsea (ChB, ChC, ChD)	Not suitable	Suitable for poorly graded fine sand; not suitable for concrete.	Not suitable	Good; good to fair shear strength; low susceptibility to frost action; erodes readily.	Good drainage; low susceptibility to frost action; good bearing capacity; erodes readily if exposed on embankments.
Clayey basin land (Cn)	Poor	Not suitable	Not suitable	Very poor; fine-textured, plastic soil.	Plastic; high water table; high content of organic matter in surface layer; high volume change; moderate to high susceptibility to frost action.

See footnotes at end of table.

of soils in Wright County, Minnesota—Continued

Soil features affecting engineering practices						
Dikes or levees	Farm ponds [2]		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
	Reservoir area	Embankment				
Organic layers not suited; underlying material has fair stability, fair resistance to piping, and slow permeability when compacted.	Suited to dugout ponds or level ditches for wildlife; high water table.	Organic layers not suited.	Needed; open and closed drains can be used for drainage.	Generally not used; drainage required.	Not needed	Generally not used.
Sandy material in upper part has poor stability and resistance to piping; substratum has fair stability and poor to fair resistance to piping.	Check each site; bottom generally requires sealed blanket.	Sandy material is unstable and pervious when compacted; underlying material has fair stability, a low seepage rate when compacted, and good to fair resistance to piping.	Not needed	Rapid intake rate; variable water-holding capacity because of thickness of overlying sand; low fertility; undulating topography; subject to wind erosion.	Very sandy; subject to erosion; difficult to establish vegetation.	Very sandy; subject to wind erosion.
High seepage rate; can be used in shells; good stability and resistance to piping.	Not suited; rapidly permeable substratum.	Good stability and compaction characteristics; suitable in pervious shells.	Not needed	Low water-holding capacity; shallow root zone; in places irrigation is not feasible.	Not suited; shallow to gravel and sand.	Sandy and droughty; in many places gravel is on the surface.
High compressibility in surface layer; impervious and low permeability when compacted; poor workability.	Suited to dugout ponds.	Impervious when compacted; good resistance to piping; fair stability.	Needed; moderately slow permeability.	Drainage needed	Not needed	Drainage needed before construction.
Poor stability; pervious when compacted; high piping hazard.	Sandy; too porous to hold water.	Not suited because of high seepage rate; high piping hazard.	Not needed	Low water-holding capacity and fertility; topography not suited; subject to wind erosion.	Not needed; high water-intake rate.	Droughty, sandy, and highly erodible; low water-holding capacity and fertility.
Fair to poor stability; poor compaction characteristics; high compressibility; impervious when compacted; high volume change.	Well suited to dugout ponds; high water table.	Fair to poor stability; high volume change; poor compaction characteristics; impervious when compacted.	Needed; plastic subsoil; moderately slow to slow permeability.	Suited but must be drained first.	Not needed	Drainage needed before construction.

TABLE 7.—*Engineering interpretations*

Soil series and map symbol	Suitability as a source of—				Soil features affecting highway location
	Topsoil [1]	Sand	Gravel	Road fill [2]	
Comfrey (Co)	Fair to good	Not suitable	Not suitable	Very poor; plastic; high compressibility; poor compaction characteristics; fair to poor shear strength.	High water table and content of organic matter in the surface layer; subject to flooding; poor stability; poor compaction characteristics.
Comfrey (Cp)	Fair; very high content of organic matter.	Not suitable	Not suitable	Wet and in depressions; plastic subsoil.	Subject to frequent floods; frequently ponded; high content of organic matter; poor stability.
Cordova (Cs, Cw) (For properties of Le Sueur soil and of Webster soil in mapping units Cs and Cw, refer to Le Sueur and Webster series, respectively, in this table.)	Fair to a depth of about 10 inches.	Not suitable	Not suitable	Very poor in plastic subsoil; fair in till substratum; moderate volume change; fair stability; high content of water in places.	High content of organic matter in the surface layer; high water table; poor to fair stability; moderate to high susceptibility to frost action.
Duelm (De) (For properties of Watseka soil in mapping unit De refer to Watseka series in this table.)	Good to a depth of about 15 inches.	Medium and coarse sand that is 10 to 20 percent fine gravel; must be washed for concrete.	Not suitable; gravel is too fine.	Good; good shear strength; good to fair stability; high water table makes excavation difficult in places.	Seasonal high water table; fair stability; high susceptibility to frost action.
Dundas (Dn, Du) (For properties of Ames soil in mapping unit Du, refer to Ames series in this table.)	Fair to good to a depth of about 12 inches.	Not suitable	Not suitable	Very poor to a depth below 3 feet; fair in till substratum; fair to good stability; high water content in places.	Fairly high water table; plastic, clayey subsoil; poor stability; low bearing capacity.
Emmert (EmB, EmC, EmD, EmE) (For properties of Milaca soil in all these mapping units, refer to Milaca series in this table.)	Fair to poor to a depth of about 8 inches.	Not suitable	Poor; consists of variable proportions of gravel and sand mixed with till.	Good; good stability and sheer strength.	Good drainage and bearing capacity.

See footnotes at end of table.

of soils in Wright County, Minnesota—Continued

Soil features affecting engineering practices						
Dikes or levees	Farm ponds [2]		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
	Reservoir area	Embankment				
Poor compaction characteristics; high compressibility; poor stability; can be used for low embankments with proper control.	Dugout ponds feasible; subject to flooding; moderate to slow permeability when compacted.	Poor stability; poor compaction characteristics; fair to poor shear strength; can be used for core material.	Not suited because of frequent flooding.	Not used; wet and frequently flooded.	Not needed	Generally not used; major reclamation needed.
High content of organic matter; poor stability and compaction characteristics.	Not suited; subject to frequent flooding; hazard of silting.	Poor stability; high compressibility; poor shear strength; poor compaction characteristics.	Not suited; frequently flooded.	Not used; wet and frequently flooded and ponded.	Not used	Not needed.
Till substratum is stable; impervious when compacted; fair to good resistance.	Suited to dugout ponds.	Stable in till substratum; impervious when compacted.	Needed; place tile in till substratum; moderately slow to slow permeability.	Generally not used; drainage is needed.	Not needed	Drainage needed before construction.
Fair stability; good shear strength; rapid seepage rate when compacted.	Generally feasible for dugout ponds; fluctuating water table; piping hazard.	Fair stability in sandy substratum; high seepage rate when compacted; difficult to establish vegetation.	Needed; tile not suited; use shallow ditches that have wide bottoms.	Generally not needed; drainage required.	Not needed	Not needed.
Poor to fair stability; can be used for low embankements with proper control.	Bottom of reservoir should be scarified and compacted.	Unstable and clayey in upper 4 feet; fair in till below; impervious when compacted; fair to good resistance to piping.	Needed; plastic soil and moderately slow to slow permeability limit success of tile for drainage.	Generally not used; slow permeability and intake rate; drainage required.	Not needed	Difficult to establish vegetation because of wetness and a plastic subsoil.
Good stability; high seepage rate when compacted; suitable for shells.	Not suited; sandy and porous substratum.	Good stability; suited to pervious shells; good resistance to piping.	Not needed	Generally not used; rolling to steep slopes.	Shallowness to gravel and sand and irregular topography make terraces unsuitable.	Shallow to gravel and sand; difficult to establish vegetation if cuts are made too deep.

TABLE 7.—*Engineering interpretations*

Soil series and map symbol	Suitability as a source of—				Soil features affecting highway location
	Topsoil [1]	Sand	Gravel	Road fill [2]	
Estherville (EsA, EsB, EsB2, EsC, EsC2, EtA, EtB, EtB2, EtC, EtC2, EtD, EtE, EvC3, EvE3).	Good to a depth of about 12 inches in mapping units EsA, EsB, EsB2, EsC, EsC2, but fair to a depth of about 8 inches in the rest.	Good, but sand is mixed with gravel; wash for concrete.	Good but gravel is mixed with sand; wash for concrete.	Good; good stability, sheer strength, and compaction characteristics.	Good drainage, good stability and sheer strength; low susceptibility to frost action.
Fairhaven (FaA, FaB, FaB2, FaC2)	Good to a depth of about 10 inches and fair below to a depth of about 20 inches.	2 to 3½ feet of overburden; material below is good source of sand, but the sand has gravel mixed with it.	Good, but the gravel has sand mixed with it.	Fair in surface layer; good in substratum; good stability and shear strength; low volume change.	Good drainage; high susceptibility to frost action; fair stability.
Glencoe (Gc)	Fair to a depth of about 20 inches.	Not suitable	Not suitable	Poor; poor to fair stability; high water content.	Very high content of organic matter in the surface layer; high water table; ponded during wet seasons; low bearing capacity; high compressibility.
Guckeen (GuA, GuB, GuC)	Fair to poor to a depth of 12 inches.	Not suitable	Not suitable	Poor; poor stability; high volume change; high susceptibility to frost action.	High content of organic matter in the surface layer; high volume change and compressibility; low bearing strength.
Hayden:					
Clay loams (HaC3, HaD3); loams (HlB, HlB2, HlC, HlC2, HlD, HlD2, HlE, HlF); soils (HnE3).	Fair to poor to a depth of about 10 inches.	Not suitable	Not suitable	Fair to good; fair stability and compaction characteristics; moderate to high susceptibility to frost action.	Good drainage; moderate to high susceptibility to frost action; moderate to high volume change; fair to good bearing capacity.
Fine sandy loams (HdA, HdB, HdB2, HdC, HdC2, HdD, HdD2).	Fair to a depth of about 12 inches.	Not suitable	Not suitable	Good to fair; fair stability and compaction characteristics; moderate to high susceptibility to frost action.	Good drainage; moderate susceptibility to frost action; moderate volume change; good to fair bearing capacity.

See footnotes at end of table.

of soils in Wright County, Minnesota—Continued

Soil features affecting engineering practices						
Dikes or levees	Farm ponds [2]		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
	Reservoir area	Embankment				
Good stability; good for pervious shells of dikes and dams.	Porous	Rapidly permeable when compacted; good stability.	Not needed	Suited, but has low water-holding capacity; frequent applications of water are needed.	Normally not needed; shallowness to gravel and sand makes terraces not suitable.	Droughty; vegetation is difficult to establish if cuts are made too deep.
Poor to fair stability and high piping hazard in the upper 3 feet; substratum has good stability; very porous.	Not suited; sandy substratum is too porous to hold water.	Substratum has good stability and is porous; suitable for shells.	Not needed	Well suited; moderate intake rate and water-holding capacity.	Moderately deep to sand and gravel; moderately rapid permeability.	Erosion hazard.
Fair stability below a depth of 3 feet; fair resistance to piping; high water content.	Suited to dugout ponds or level ditches for wildlife; high water table.	Fair stability; high water content; impervious when compacted; good to fair resistance to piping.	Needed; in places surface ditches are needed in addition to tile.	Suited, but must be drained first.	Not needed	Not needed.
Poor stability; good resistance to piping; impervious when compacted; substratum suitable for cores and blankets.	Generally suited; underlain by sand at a depth of 4 to 6 feet in a few places.	Plastic clay at a depth of 3 or 4 feet; substratum has good to fair resistance to piping; is impervious when compacted and has poor compaction characteristics.	Not needed	Generally not used; slow intake rate; high moisture-holding capacity.	Moderately well drained; slow permeability makes terraces poorly suited.	Plastic, clayey subsoil; difficult to construct waterways and to establish vegetation.
Fair to good stability and compaction characteristics; impervious when compacted.	Bottoms are semipervious to impervious if scarified and compacted.	Fair stability; impervious when compacted; fair to good resistance to piping.	Not needed	Suited; low intake rate; moderate permeability.	Difficult to construct terraces because of irregular slopes.	Fertilizer and mulch needed to establish sod rapidly.
Fair to good stability; fair to good compaction characteristics; impervious when compacted.	Bottoms are semipervious to impervious if scarified and compacted.	Fair stability; impervious when compacted; fair to good resistance to piping.	Not needed	Suited; moderate intake rate and permeability.	Difficult to construct because of irregular slopes.	Fertilizer and mulch needed to establish sod rapidly.

TABLE 7.—*Engineering interpretations*

Soil series and map symbol	Suitability as a source of—				Soil features affecting highway location
	Topsoil [1]	Sand	Gravel	Road fill [2]	
Hubbard: Loamy sands (HrA, HrB, HrB2, HrC, HrC2, HrE2).	Poor	Suitable for poorly graded, medium and coarse sand; not suitable for concrete.	Not suitable	Good; erodes readily; good compaction characteristics and shear strength; stable.	Good drainage, stability, and shear strength; low susceptibility to frost action.
Sandy loams (HuA, HuA2, HuB, HuB2, HuC, HuC2).	Fair to a depth of about 12 inches.	Good below a depth of 30 inches; poorly graded medium and coarse sand; wash for concrete.	Not suitable	Good; good shear strength; low shrink-swell potential.	Good drainage, stability, and shear strength; low to moderate susceptibility to frost action.
Hubbard, gravelly subsoil variants (HsA, HsB, HsB2, HsC).	Poor	Good; is 10 to 30 percent fine gravel; wash for concrete.	Not suitable	Good; good compaction characteristics, good shear strength, and stability; low compressibility.	Good drainage, stability, and shear strength; low susceptibility to frost action.
Lake borders (Lb)	Good to a depth of 12 to 20 inches.	Not suitable	Not suitable	Very poor; high content of organic matter in the surface layer; fair stability below a depth of 4 feet; moderate to high susceptibility to frost action; high water table.	Very high content of organic matter in the surface layer; high water table; low bearing capacity.
Lester (LcC3, LcD3, LcE3, LeB, LeB2, LeC, LeC2, LeD, LeE, LeF, LtB, LtB2, LtC, LtD). (For properties of Estherville soils in mapping units LtB through LtD, refer to Estherville series in this table.)	Fair to good to a depth of about 10 inches.	Not suitable	Not suitable	Fair; medium to high compressibility; fair stability and shear strength; moderate to high susceptibility to frost action.	Good drainage; fair shear strength and bearing capacity; moderate to high susceptibility to frost action.
Lester, silty variants (LrA, LrB, LrB2, LrC2).	Good to a depth of about 10 inches; good at a depth of more than 2 feet if fertilizer is added.	Not suitable	Not suitable	Fair; poor to fair stability and shear strength; high susceptibility to frost action; susceptible to liquefaction.	Good drainage; high susceptibility to frost action; fair stability; susceptible to liquefaction; close control needed for compaction.

See footnotes at end of table.

of soils in Wright County, Minnesota—Continued

Soil features affecting engineering practices						
Dikes or levees	Farm ponds [2]		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
	Reservoir area	Embankment				
Fair to poor stability; piping hazard; rapid permeability when compacted.	Not suited; very porous.	Poor resistance to piping; too porous to hold water.	Not needed	Very droughty; rapid intake rate; very low water-holding capacity; frequent applications of water needed.	Very porous; terraces are generally not needed.	Very droughty; difficult to establish vegetation.
Poor stability in upper 2 feet; substratum has poor to fair stability and resistance to piping; suitable for dikes with flat slopes.	Not suited; porous.	Poor stability; rapid permeability when compacted; poor resistance to piping.	Not needed	Well suited; droughty; rapid intake rate; low water-holding capacity; requires frequent applications of water.	Suited; high intake rate; very erodible; difficult to establish vegetation.	Sandy; difficult to establish vegetation.
Fair to poor stability; poor to fair resistance to piping; rapid permeability when compacted.	Not suited; very porous.	Poor to fair stability and resistance to piping; rapid permeability when compacted; can be used in pervious shells.	Not needed	Very droughty; rapid intake rate; very low water-holding capacity; frequent applications of water needed.	Rapid intake rate makes terraces unnecessary.	Droughty; difficult to establish vegetation.
Poor stability in upper 4 feet; fair stability in till substratum; low permeability when compacted; not well suited to shells but can be used for pervious cores.	Excavated ponds hold water because of high water table.	Fair to poor stability in underlying material; poor to fair resistance to piping; semipervious when compacted.	Needed, but development of outlets necessary.	Generally not used.	Not needed	Generally not needed.
Fair to good stability; impervious when compacted.	Suited; semipervious when scarified and compacted.	Fair stability; fair to good compaction characteristics and resistance to piping; impervious when compacted.	Not needed	Characteristics are generally favorable.	Suited; irregular topography makes terraces difficult to construct.	No important limitations.
Poor to fair stability; poor compaction characteristics; semipervious when compacted.	Moderate seepage rate if bottom is scarified and compacted.	Poor stability and compaction characteristics; poor resistance to piping; semipervious when compacted; can be used for embankments with proper control.	Not needed	Suited; generally good characteristics for irrigation.	Well suited	Erosion hazard.

TABLE 7.—*Engineering interpretations*

Soil series and map symbol	Suitability as a source of—				Soil features affecting highway location
	Topsoil [1]	Sand	Gravel	Road fill [2]	
Le Sueur (LuA, LuB)	Fair to a depth of about 12 inches.	Not suitable	Not suitable	Fair; fair stability; high susceptibility to frost action.	Moderately high seasonal water table; plastic subsoil; fair stability; moderate to high compressibility; high susceptibility to frost action.
Marna (Ma)	Fair	Not suitable	Not suitable	Clay to a depth between 3 and 4 feet; substratum is fair; fair stability; high susceptibility to frost action; high water content.	High content of organic matter in the surface layer; the water table, susceptibility to frost action, volume change, and compressibility are high.
Marsh (Mh)	Check each site.				
Milaca (MlB2)	Good	Not suitable	Not suitable	Fair to poor; moderate to high volume change; poor to fair compaction characteristics.	Good drainage; moderate to high susceptibitity to frost action; variable material.
Muck, deep (Mu)	Fair to good if mixed with mineral soil.	Not suitable	Not suitable	Not suitable	High water table; remove muck to mineral material.
Nessel (NeA, NeB)	Good	Not suitable	Not suitable	Plastic subsoil; fair in substratum; fair stability; fair to good compaction characteristics; moderate to high susceptibility to frost action.	Moderate to high susceptibility to frost action; plastic subsoil; moderately high water table.
Peat and muck (Pa, Pm, Ps)	Not suitable	Not suitable	Not suitable	Not suitable	Organic material; high water table; avoid using areas for building highways; if necessary to use for highways, remove peat and muck to depth of the underlying mineral material.

See footnotes at end of table.

of soils in Wright County, Minnesota—Continued

Soil features affecting engineering practices						
Dikes or levees	Farm ponds [2]		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
	Reservoir area	Embankment				
Stable; fair compaction characteristics; fair to good resistance to piping.	Impervious when compacted.	Poor in upper 3 feet; fair stability in substratum; impervious when compacted.	Generally not needed.	Generally not used but soil characteristics are favorable.	Generally not used.	No important limitations.
Poor stability; impervious when compacted; can be used with close control.	Well suited to dugout ponds; impervious when bottom is scarified and compacted.	Poor to a depth of 3 or 4 feet; fair stability in substratum; impervious when compacted.	Needed; generally tile is used; moderately slow to slow permeability.	Not used; high water table and high water-holding capacity.	Not needed	Drainage needed before construction.
Poor to good stability and compaction characteristics; fair to poor resistance to piping.	Variable substratum; bottom should be scarified and compacted.	Poor to good stability and good compaction characteristics; medium to low permeability when compacted; fair to poor resistance to piping.	Not needed	Generally favorable soil characteristics.	Difficult to install because of complex slopes.	Erosion hazard.
Not suited	High water table; generally suitable, but check depth of muck and type of underlying material.	Organic material not suitable for embankments.	Drainage required; open and closed drains can be used.	Not needed	Not suited	Not needed.
Fair stability and compaction characteristics; impervious when compacted.	Impervious when bottom is scarified and compacted.	Fair to good stability; impervious when compacted.	Not needed	Suited but not used; low intake rate; high water-holding capacity.	Not needed; slopes generally are short.	Dense clayey subsoil; difficult to establish vegetation in exposed areas.
Not suited	Suited for dugout ponds or level ditches for wildlife; high water table.	Not suited	Needed; open and closed drains are suited on all but the mapping unit Ps.	Drainage required; open and closed drains are suited.	Not needed	Not suited.

TABLE 7.—*Engineering interpretations*

Soil series and map symbol	Suitability as a source of—				Soil features affecting highway location
	Topsoil [1]	Sand	Gravel	Road fill [2]	
Rasset (RhA, RhB, RhB2, RhC, RhC2). (For properties of Hubbard soils in all these mapping units, refer to Hubbard series in this table.)	Fair	Fair; generally has strata of gravel that is high in content of shale.	Poor; mainly sand and thin strata of very coarse sand and fine gravel that is high in content of shale.	Good; good stability and shear strength; low volume change.	Low to moderate susceptibility to frost action; moderately high water table in some level areas; good stability and bearing capacity.
Salida: Gravelly sandy loams (SaB, SaC, SaE).	Not suitable	Good, but mixed with gravel; wash for concrete.	Good; consists of stratified layers of sand and fine gravel; wash for concrete.	Very good; excellent shear strength; very low compressibility; low volume change.	Low susceptibility to frost action; good stability and shear strength.
Complexes (ScB, ScC, ScE)	Not suitable	Good, but mixed with gravel; wash for concrete.	Good; contains many cobblestones and larger stones.	Excellent; good stability; excellent shear strength; low volume change.	Good drainage; high bearing capacity; pebbles, cobblestones, and boulders interfere with grading in places.
Sattre, silty variants (SeA, SeB)	Good to a depth of 8 inches; fair to poor below to a depth of about 20 inches.	Good below a depth of 3 feet, but is mixed with gravel; wash for concrete.	Good below a depth of 3 feet, but is mixed with sand; wash for concrete.	Good below a depth of 3 feet; good stability and shear strength; low volume change.	Good drainage; high susceptibility to frost action; fair stability.
Storden (SlC2, SlD2, SlE2, StC3, StD3). (For properties of Lester soil in all these mapping units, refer to Lester series in this table.)	Poor; material is limy.	Not suitable	Not suitable	Fair to good; stable; good compaction characteristics; fair shear strength; moderate volume change.	Good drainage; moderate to high susceptibility to frost action; fair shear strength; good to fair workability.
Talcot (Tc)	Good	Poor; 2 to 4 feet of overburden over stratified gravel and sand; difficult to excavate because of high water table.	Poor; good gravel for concrete if washed; difficult to excavate because of high water table.	Poor; high content of organic matter in upper 2 feet; stratified sand and gravel below, but high water table makes excavation difficult.	High water table; seasonally ponded; moderate to high susceptibility to frost action; high to very high content of organic matter to a depth of about 20 inches.

See footnotes at end of table.

of soils in Wright County, Minnesota—Continued

Soil features affecting engineering practices						
Dikes or levees	Farm ponds [2]		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
	Reservoir area	Embankment				
Fair to good stability; suitable for pervious shells.	Not suited; porous.	Fair to good stability; fair resistance to piping; suitable for pervious shells.	Not needed	High to moderate intake rate; low water-holding capacity.	Generally not needed, because of high intake rate.	Drought; difficult to establish vegetation.
Good stability; suitable for pervious shells.	Not suited; very porous.	Good stability; suitable for pervious shells.	Not needed	Not suited; very droughty soils; very shallow root zone.	Not suited; very shallow to gravel and sand.	Very droughty; difficult to establish and maintain vegetation.
Good stability; rapid permeability when compacted.	Not suited; very porous.	Good stability and compaction characteristics; very low volume change and compressibility; good resistance to piping; suited to pervious shells for dikes and embankments.	Not needed	Very shallow to gravel and sand; very low to low water-holding capacity.	Not suited; very shallow to gravel and sand.	Droughty; in many places gravel is on the surface; difficult to establish vegetation.
Poor to fair stability and high piping hazard in upper 3 feet; good stability in substratum; high permeability when compacted.	Not suited; porous substratum.	Poor stability in upper 2 to 3 feet; good stability in substratum; suitable for pervious shells.	Not needed	Well suited; moderate intake rate and water-holding capacity.	Moderately deep to sand and gravel; erosion hazard.	Erosion hazard.
Fair to good stability and compaction characteristics; impervious when compacted; fair to good resistance to piping.	Impervious when bottom is scarified and compacted.	Stable; good for impervious cores or blankets; good compaction characteristics.	Not needed	Generally not feasible because of rolling to steep slopes.	Slopes are irregular and complex in many places.	Fertilizer and mulch necessary to establish sod rapidly.
Substratum suitable for pervious shells; stable.	Very high water table; pervious substratum; generally good sites for dugout ponds.	Not suited in upper 3 feet because of high content of organic matter; good stability below a depth of 3 feet; suitable for pervious shells.	Needed; surface ditches needed in places in addition to tile; substratum, sloughs and caves easily.	Not used; drainage needed.	Not needed	Not generally used.

TABLE 7—*Engineering interpretations*

Soil series and map symbol	Suitability as a source of—				Soil features affecting highway location
	Topsoil [1]	Sand	Gravel	Road fill [2]	
Terril:					
Loam, occasionally flooded (TeA).	Good to a depth of 2 to 3 feet or more.	Not suitable.	Not suitable.	Fair; fair stability and compaction characteristics; moderate to fair shear strength; moderate susceptibility to frost action; subject to flooding.	Subject to flooding; fair stability; moderate susceptibility to frost action.
Loam, sandy substratum (TlA).	Good to a depth of several feet.	Poor; more than 4 feet of overburden; moderately high water table in some areas.	Poor; thick overburden; mainly sandy substratum.	Poor to fair to a depth of more than 4 feet; good in substratum; good stability and shear strength.	High susceptibility to frost action to a depth of more than 4 feet; poor to fair stability; moderately high water table.
Undifferentiated—Terril soils (TsB).	Good to a depth of 2 to 3 feet or more.	Not suitable.	Not suitable.	Poor; poor stability; high susceptibility to frost action; fair shear strength.	Poor stability; high susceptibility to frost action; high content of organic matter to a depth of several feet; subject to liquefaction.
Wadena (WaA, WaB, WaB2, WaC2).	Good to a depth of about 14 inches.	Good; stratified layers of coarse sand and fine gravel; wash for concrete.	Good; stratified layers of coarse sand and fine gravel; wash for concrete.	Good; good stability and shear strength; low compressibility; good compaction characteristics.	Moderate to high susceptibility to frost action; good stability and drainage.
Watseka (Mapped only with soils of the Duelm series.)	Fair to a depth of about 12 inches.	Good; medium and coarse sand that is 10 to 20 percent fine gravel; wash for concrete; high water table.	Not suitable; gravel is too fine.	Good; fair to good stability; good shear strength.	Seasonal high water table; moderate susceptibility to frost action; good bearing capacity.

See footnotes at end of table.

of soils in Wright County, Minnesota—Continued

Soil features affecting engineering practices						
Dikes or levees	Farm ponds [2]		Agricultural drainage	Irrigation	Terraces and diversions	Waterways
	Reservoir area	Embankment				
Fair stability; fair to good compaction characteristics; fair to poor resistance to piping; low to moderate permeability when compacted.	Subject to flooding; high water table; piping hazard.	Fair stability; fair to good compaction characteristics; fair to poor resistance to piping.	Not needed	Favorable soil characteristics but subject to flooding.	Not needed	Erosion hazard.
Fair to poor stability to a depth of more than 4 feet; substratum is stable; good compaction characteristics.	Moderately high water table; pervious substratum; some sites are suited to dugout ponds.	Upper 4 feet has poor to fair stability, poor resistance to piping, and medium to high compressibility; substratum has fair stability and good to fair resistance to piping.	Not needed	Generally not used, but characteristics are favorable.	Not needed	No important limitations.
Poor stability; semipervious to pervious when compacted; can be used for low embankments with close control.	Semipervious to impervious when scarified and compacted; piping hazard.	Poor stability and resistance to piping; fair shear strength.	Not needed	Suited	No important limitations.	No important limitations.
Fair stability; can be used in dikes with flat slopes; suitable for pervious shells.	Not suited; rapidly permeable substratum.	Fair stability and fair to poor resistance to piping in the upper 2 to 3 feet; substratum has good stability; suitable for pervious shells.	Not needed	No important limitations.	Moderately deep to porous substratum.	Moderately deep to porous substratum; cuts must not be too deep.
Poor to fair stability; piping hazard; can be used for low dikes.	Moderately high water table; rapidly permeable substratum; not suited to dugout ponds, because depth to water table generally is too variable.	Poor to fair stability; poor resistance to piping; pervious when compacted; can be used in pervious cores.	Not needed	Low water-holding capacity and fertility; rapid intake rate.	Not needed	Not needed.

TABLE 7—*Engineering interpretations*

Soil series and map symbol	Suitability as a source of—				Soil features affecting highway location
	Topsoil [1]	Sand	Gravel	Road fill [2]	
Webster (Mapped only with soils of the Cordova series.)	Fair to a depth of about 12 inches.	Not suitable	Not suitable	Poor in upper 2 feet; fair in till substratum; fair stability and compaction characteristics; in places content of water is high.	High content of organic matter in the surface layer; high water table; poor stability; moderate to high susceptibility to frost action.
Webster, silty variant (We)	Good to a depth of about 16 inches.	Not suited	Not suited	Poor; silty and has poor stability; subject to liquefaction; high susceptibility to frost action; in places has high water content.	High content of organic matter in the surface soil; poor stability; susceptible to liquefaction; high susceptibility to frost action; high water table.

[1] Refers to slightly eroded soils. Moderately eroded soils are less suitable.

good management and careful design. The rating *poor* means that limitations are severe and suitability for use is questionable, and *very poor*, that problems are serious, limitations are severe, and usage generally is unsound.

A low building, as referred to in the discussion of each group, is a building that is no more than two stories high. The substratum generally provides the base for foundations, and it therefore is the soil material rated. In considering the ratings for bearing capacity given in most of the groups in the discussion of the suitability of the soils for foundations for low buildings, engineers and others should not apply specific values to the estimates given for bearing capacity of soils.

GROUP 1 FOR BUILDING SITES

This group consists of excessively drained to well-drained soils of the Braham, Anoka, Burnsville, Chelsea, Estherville, Fairhaven, Hubbard, Rasset, Salida, Sattre, and Wadena series. These soils have slopes of 0 to 6 percent. The surface layer ranges from fine sand to silt loam, and the soils are underlain by sand or sand and gravel within a depth of 3½ feet. Soils in this group generally do not have a seasonally high water table and are not subject to flooding, but small depressional areas occur in a few of the soils. Some of the soils are moderately eroded.

The Fairhaven, Sattre, and Wadena soils in this group are good for crops. The rest of the soils are droughty and are fairly good to poor for crops.

All of the soils in this group provide very good sites for residences, stores, factories, schools, and similar facilities. Also many of the soils occupy fairly broad, level areas suitable for shopping centers.

The general suitability of the soils in this group for foundations for low buildings is good. The soils have good drainage, bearing capacity, and shear strength and low shrink-swell potential. Susceptibility to frost action is low. There are no serious problems in grading or in excavating, though in places the Burnsville soils contain a few large stones.

Most of the soils in this group are suitable as fields for septic tanks because they have good permeability, are not affected by a seasonally high water table, and absorb sewage effluent fairly rapidly. The Braham and Anoka fine sands and loamy fine sands and the Rasset and Hubbard soils, however, have clayey layers in places in the substratum that may impede the flow of effluent from a septic tank. In areas of these soils, percolation tests should be made by trained personnel to determine if a particular site is suitable for a septic tank. Soils that have a gravelly substratum may permit unfiltered sewage effluent to travel a long distance. Therefore if soils in this group are used as fields for septic tanks, care is needed to keep the sewage effluent from contaminating nearby water supplies.

Grass sod can be established readily on the Fairhaven, Sattre, and Wadena soils in this group. The other soils are sandy and droughty, and on these soils a topdressing of loamy material is needed before seeding grass or laying sod.

GROUP 2 FOR BUILDING SITES

This group consists of excessively drained to well-drained soils of the Braham, Anoka, Burnsville, Chel-

of soils in Wright County, Minnesota—Continued

Soil features affecting engineering practices						
Dikes or levees	Farm ponds [2]		Agricultural drainage	Irragation	Terrrces and diversions	Waterways
	Reservoir area	Embankment				
Fair stability; impervious when compacted.	Suited to dugout ponds; impervious when compacted.	Stable in till substratum; impervious when compacted; fair to good resistance to piping.	Needed; moderately slow permeability.	Generally not used; drainage required.	Not needed_____	Drainage needed before construction.
Poor stability; poor resistance to piping; semipervious when compacted.	Piping hazard; low to moderate permeability when compacted; suited to dugout ponds.	Poor stability and resistance to piping; subject to liquefaction; in places can be used for embankments with proper control.	Needed; moderately slow permeability; in places fine sandy layers in substratum cause sloughing and caving of ditchbanks and of trenches for tile.	Suited, but must be drained first.	Not needed_____	Difficult to construct because of wetness.

[2] Refers to substratum or till unless a particular layer is specified.

sea, Estherville, Fairhaven, Hubbard, Rasset, Salida, and Wadena series. These soils are similar to those in group 1 for building sites, but occupy smaller areas and have slopes of 6 to 12 percent. The surface layer ranges from fine sand to silt loam, and the soils are underlain by sand or sand and gravel within a depth of 3½ feet. Soils in this group do not have a seasonally high water table. Water moves rapidly to very rapidly through the coarse-textured substratum. Some of the soils are moderately eroded, and a few are severely eroded.

The soils in this group are droughty and are susceptible to erosion. They are therefore only fair to poor for crops. All of these soils provide good sites for residences and small stores. The areas generally are too small, however, for shopping centers, factories, schools, or similar kinds of buildings.

The general suitability of soils in this group for foundations for low buildings is good. Drainage is very good, and the soils have good bearing capacity and shear strength and low shrink-swell potential. Susceptibility to frost action is low. The moderate slopes do not interfere seriously with construction, but in places the Burnsville soils have large stones that cause problems in grading and in excavating.

Most of the soils in this group are suitable as fields for septic tanks because they have good permeability, are not affected by a seasonally high water table, and absorb sewage effluent fairly rapidly. The Braham and Anoka fine sands and loamy fine sands and the Rasset and Hubbard soils, however, have clayey layers in places in the substratum that may impede the flow of effluent from a septic tank. In areas of these soils, percolation tests should be made by trained personnel to determine if the soils are suitable for septic tanks. Soils that have a gravelly substratum may permit unfiltered sewage effluent to travel a long distance. Therefore if soils in this group are used as fields for septic tanks, care is needed to keep from contaminating nearby water supplies.

Grass sod can be established readily on the Fairhaven soils in this group. The other soils are sandy and droughty, and on these a topdressing of loamy material is needed before seeding grass or laying sod.

GROUP 3 FOR BUILDING SITES

In this group are excessively drained soils of the Braham, Anoka, Burnsville, Chelsea, Estherville, Hubbard, and Salida series. These soils have slopes of 12 to 35 percent. The surface layer ranges from fine sand to loam, and the soils are underlain by sand or sand and gravel within a depth of 2 feet. The water table is very low, and water moves rapidly to very rapidly through the coarse-textured substratum. The Hubbard soil is moderately eroded, and the Burnsville soils and Estherville soils that have slopes of 12 to 25 percent are severely eroded.

Because of droughtiness and steep slopes, the soils in this group are not suited to crops.

These soils are fair to very poor for use as building sites. The slopes are somewhat steep for stores, schools, factories, and hospitals. The soils that have slopes of 12 to 18 percent are satisfactory for residences, but those that have slopes of more than 12 percent have moderate to severe problems of accessibility and construction. Costs of building design and of excavating and grading

are higher than for soils in groups 1 and 2 for building sites.

The general suitability of soils in this group for foundations for low buildings is good. Drainage is good, and the soils generally have good shear strength and bearing capacity and low shrink-swell potential. Susceptibility to frost action is low. Areas that have slopes of more than 18 percent are subject to very slow creep in places. Also in places the Burnsville soils have large stones that cause problems in grading and excavating. All of the soils are subject to severe erosion, and care is needed during and after construction for control of erosion. Serious damage to building sites on these soils and to areas below are likely to result from erosion.

The soils in this group are severely limited for use as septic tank filter fields. They have good drainage and absorb water and sewage effluent well. The steep slopes, however, make it difficult to lay out and construct trenches for filter fields for septic tanks and in places make seepage beds impractical. Because of the stronger slopes, the risk of polluting areas downslope is greater than on soils in groups 1 and 2 for building sites. Soils that have a gravelly substratum may permit unfiltered sewage effluent to travel a long distance. Care is therefore needed to keep from contaminating nearby water supplies. The Braham and Anoka fine sands have clayey layers in the substratum that may impede the flow of effluent from the septic tank and cause it to seep out on the hillside further downslope. In areas of these soils, percolation tests should be made by trained personnel to determine if a particular site is suitable for a septic tank.

The soils in this group are very droughty, and establishing and maintaining good lawns and vigorous shrubs is difficult. A topdressing of loamy material, 6 to 12 inches thick, is needed on these soils before seeding grass or laying sod.

GROUP 4 FOR BUILDING SITES

This group consists of deep, well-drained, loamy soils of the Burnsville, Emmert, Estherville, Hayden, Lester, and Milaca series. These soils have slopes of 2 to 6 percent. They do not have a seasonally high water table and are not subject to flooding. Permeability is moderate. Some of the soils are moderately eroded.

The soils in this group are very good for crops and are among the best soils for agriculture in the county.

All the soils in this group provide good sites for residences, stores, factories, schools, and similar facilities. The general suitability of the soils for foundations for low buildings is fair to good. Drainage is good. Also the soils have good to fair bearing capacity, fair shear strength, and moderate shrink-swell potential. They are subject to frost action. Large stones and boulders are not a problem in most of the soils, but they cause difficulty in grading and excavating in places in the Burnsville-Hayden, Lester-Estherville, and Emmert-Milaca complexes.

The soils in this group are not so suitable for septic tanks as those of groups 1 and 2, because they are less permeable and sewage effluent moves more slowly through the substratum. If these soils are used as fields for septic tanks, the fields must be larger than for soils of groups 1 and 2. Percolation tests, which determine the absorptive capacity of a soil, are generally needed on all soils in this group before selecting a particular site for a septic tank filter field or seepage pit.

All of the soils in this group are good for landscaping, including the seeding of grass, laying of sod, and planting of trees and shrubs.

GROUP 5 FOR BUILDING SITES

In this group are deep, well-drained, loamy soils of the Burnsville, Emmert, Estherville, Hayden, Lester, Milaca, and Storden series. These soils have slopes of 6 to 12 percent, but they are otherwise similar to those of group 4. Depth to the water table is more than 10 feet. Permeability is moderate. Many of the soils are moderately eroded, and some are severely eroded.

The soils in this group are only fairly good for crops. The erosion hazard is severe and limits use of the soils for farming.

The soils in this group provide good sites for residences and small stores, but the areas are generally too small for shopping centers, factories, schools, and similar facilities. Because of the moderate slopes, building costs are somewhat higher than for soils in group 4.

The general suitability of soils in this group for foundations for low buildings is fair to good. The soils have good drainage, good to fair bearing capacity, fair shear strength, and moderate shrink-swell potential. They are subject to frost action. Large stones and boulders are not a problem in most of the soils, but they cause difficulty in grading and excavating in places in the Burnsville-Hayden complexes, in the Lester-Estherville complex, and in the Emmert-Milaca complex.

The soils in this group are not so suitable for septic tanks as those of groups 1 and 2, because they are less permeable and sewage effluent moves more slowly through the substratum. If these soils are used as fields for septic tanks, the fields must be larger than for soils of groups 1 and 2. Percolation tests, which determine the absorptive capacity of a soil, are generally needed on all soils in this group before selecting a particular site for a septic-tank filter field or seepage pit.

All soils in this group are very good for landscaping, including the seeding of grass, laying of sod, and planting of trees and shrubs.

GROUP 6 FOR BUILDING SITES

This group consists of deep, well-drained, loamy soils of the Burnsville, Emmert, Estherville, Hayden, Lester, Milaca, and Storden series. These soils have slopes of 12 to 18 percent. Depth to the water table is more than 10 feet. Permeability is moderate. A few of the soils are moderately eroded, and a few others are severely eroded.

The soils in this group can be used only occasionally for crops. The severe erosion hazard limits use of the soils for farming.

These soils are only fair for building sites. The slopes are satisfactory for residences but are too steep for stores, factories, schools, and other facilities. They also cause problems in construction and limit accessibility. Costs of bulding designs and of excavating and grading generally are higher than for soils in groups 4 and 5.

The general suitability of the soils in this group for foundations for low buildings is fair to good. The soils have good drainage, good to fair bearing capacity, fair

shear strength, and moderate shrink-swell potential. They are subject to frost action. Large stones and boulders are not a problem in most of the soils, but in places in the Burnsville-Hayden complex, in the Emmert-Milaca complex, and in the Lester-Estherville complex they interfere with grading and excavating. The soils are subject to severe erosion, and care is needed during and after construction to control erosion.

The soils in this group are less suitable for septic tanks than those in groups 1 and 2, because they are less permeable and sewage effluent moves more slowly through the substratum. Also the moderately steep slopes make it difficult and expensive to lay out trenches for filter fields for septic tanks. If these soils are used as fields for septic tanks, the fields must be larger than those used for soils of groups 4 and 5. Also the risk of polluting areas downslope is greater. Percolation tests, which determine the absorptive capacity of a soil, are needed on all soils in this group before any septic tank is installed.

Runoff is rapid on soils of this group, and establishing grass seedings is difficult unless a mulch of straw is used. The soils are otherwise good for landscaping, including the laying of sod and the planting of shrubs and trees.

GROUP 7 FOR BUILDING SITES

This group consists of deep, well-drained, loamy soils of the Burnsville, Emmert, Hayden, Lester, Milaca, and Storden series. These soils have slopes of 18 to 35 percent. Depth to the water table is more than 10 feet. Permeability is moderate. Some of the soils are moderately eroded, and a few are severely eroded.

Because of the steep slopes, the soils in this group are not suited to crops. They are only fair for pasture.

Soils in this group make poor to very poor building sites. They are suited only for residential construction. The slopes are too steep for shopping centers, factories, schools, and similar facilities. They also cause serious problems in construction and limit accessibility. The costs of building designs and of excavating and grading are higher than for soils in groups 4, 5, and 6. Many areas, however, particularly those near lakes or streams, provide scenic outlooks that enhance their value for residences.

The general suitability of the soils in this group for foundations for low buildings is fair to good. The soils have good drainage, good to fair bearing capacity, fair shear strength, and moderate to high shrink-swell potential. They are subject to frost action. Large stones or boulders are not a problem in most of the soils, but in many places in the Burnsville-Hayden and Emmert-Milaca complexes they interfere with grading and excavating. Erosion is difficult to control both during and after construction.

The steep to very steep slopes and moderate permeability make these soils poorly suited to trenches for filter fields for septic tanks. Costs are high, and the fields are difficult to lay out and must be larger than for soils of groups 4, 5, and 6. The risk of polluting areas downslope is also greater. Percolation tests, which determine the absorptive capacity of a soil, are needed on all soils in this group before any septic tank is installed.

Runoff is very rapid on these soils. It is therefore difficult to establish grass seedings unless a straw mulch is used and other special care is taken. The soils are otherwise good for landscaping, including the laying of sod and the planting of trees and shrubs.

Many areas of these soils are wooded and are near lakes and streams, which makes them desirable as sites for parks, picnic areas, and camping grounds. Such areas are suitable for hunting, fishing, skiing, tobogganing, and other recreational developments.

GROUP 8 FOR BUILDING SITES

This group consists of moderately well drained and somewhat poorly drained, medium-textured and moderately fine textured soils of the Duelm, Guckeen, Le Sueur, Nessel, Terril, and Watseka series. These soils have slopes that range from 0 to 12 percent, but in most places slopes range from 0 to 2 percent. The water table in all of the soils is at a depth of 2 to 4 feet. Permeability is moderate to moderately slow.

The soils in this group are among the best in the county for crops. They are only fair to poor for building sites because of the seasonal fairly high water table.

The general suitability of these soils for foundations for low buildings is poor. The soils have fair to poor bearing capacity and shear strength, and low to high shrink-swell potential. Susceptibility to frost action is moderately high to high. If these soils are used for residential or commercial construction, fill material must be used to raise the foundations above the water level. Artificial drainage is needed, and tile generally can be used. Trafficability is poor, and roads on these soils must be well surfaced. The Terril soils also are subject to sidehill seepage.

The soils in this group are not suitable as fields for septic tanks. If they are used for this purpose, the distribution lines will be below water for long periods.

All of the soils in this group are good for landscaping, including the seeding of grass, laying of sod, and planting of trees and shrubs. Trees and shrubs that withstand slight wetness are suitable for planting.

GROUP 9 FOR BUILDING SITES

In this group are poorly drained and somewhat poorly drained, medium-textured and moderately fine textured soils of the Ames, Biscay, Canisteo, Cordova, Dundas, Le Sueur, Marna, and Webster series. These soils have slopes of 0 to 2 percent. Depth to the water table ranges from 1 to 3 feet. Permeability is moderate to moderately slow.

The soils in this group are good for crops if adequate drainage is provided. Wetness makes the soils poor for building sites.

The general suitability of soils in this group for foundations for low buildings is poor. The soils have fair to poor bearing capacity and shear strength and low to high shrink-swell potential. Susceptibility to frost action is high. If these soils are used for residential or commercial construction, fill material must be used to raise the foundations above the water level. Artificial drainage is also needed, and tile generally can be used. All of these soils are sticky when wet. Trafficability is poor.

The soils in this group are not suitable for use as fields for septic tanks. If they were used for this purpose, the distribution lines would be below water for long periods.

All of the soils are good for landscaping, including the seeding of grass, laying of sod, and planting of trees and shrubs. Trees and shrubs that withstand wetness are suitable for planting.

GROUP 10 FOR BUILDING SITES

This group consists of poorly drained and very poorly drained soils of the Blue Earth, Glencoe, and Talcot series and of the miscellaneous land types Beach materials, sandy; Clayey basin land; Lake borders; Marsh; Muck, deep; and Peat and mucks. All of these soils are in depressions and have a very high water table. Unless they are artificially drained, these soils are seasonally ponded. Depth to the water table is less than 1 foot.

The soils in this group are good for crops if they are artificially drained. Undrained areas are fair for wild hay and pasture.

These soils make very poor building sites. Wetness severely limits use of the areas for residences or for commercial buildings. The soils have fair to poor bearing capacity and shear strength and low to high shrink-swell potential. Susceptibility to frost action is high. If these soils are used for residential or commercial construction, fill material must be used to raise the foundations above the water level. Artificial drainage also must be provided. The Peat and mucks should be completely removed before the fill is added. Trafficability of all the soils is very poor.

These soils are not suitable as fields for septic tanks. If they were used for this purpose, the distribution lines would be below water for long periods.

Areas of these soils can be developed as habitats for wildlife. Some areas have high value for parks and recreational areas.

GROUP 11 FOR BUILDING SITES

This group consists of Alluvial land and of soils of the Becker, Comfrey, and Terril series. These soils are on bottom lands along streams and are subject to variable flooding. They have a seasonally high water table.

Some soils in this group are flooded infrequently and are good for crops. Others are subject to frequent flooding and are used mostly for pasture.

The soils in this group provide very poor sites for homes or other buildings unless they are protected from flooding. Some areas have value as parks and recreational areas. Many areas are suitable for wildlife sanctuaries. The sites that are flooded infrequently are drier than those that are flooded more often and in places make good campsites and picnic areas.

Soils and Recreation

The many lakes and streams, the wooded hills, and the picturesque scenery in Wright County provide ample opportunity for recreational development. Most recreation in the county is concentrated around a few lakes, but many other lakes and other areas could be developed for this use (fig. 28). This section is designed to help determine the suitability of the various soils for recreational development.

In table 8 each soil in the county is rated for selected recreational purposes and limitations for these uses are given. The ratings are based on soil features and do not include other items that may be important in selecting an area for the purposes stated. A rating of *none to slight* means that the soil is very suitable for the particular use; a rating of *moderate* indicates that the soil has limitations in use but that it can be used under good management; a rating of *severe* indicates that the soil has limiting characteristics that make its use for recreational purposes questionable; a rating of *very severe* means that use of the soil is extremely limited or is unsound. In the paragraphs that follow a general discussion of the limitations of the soils for selected recreational uses is given.

Soil limitations for intensive play areas.—Table 8 shows that the soils have a wide range in limitations for use as intensive play areas. The ratings apply to areas to be developed for playgrounds and for fields for baseball, football, badminton, and similar organized games. Such areas are subject to intensive foot traffic. Areas selected for intensive play generally require a nearly level surface, good drainage, soil texture and consistence that give a firm surface, and freedom from flooding.

Soil limitations for picnic areas subject to intensive use.—The soils are also rated in table 8 for degree of soil limitation for picnic areas subject to intensive use. The ratings are based on soil features only. They do not include other factors that may affect the desirability of the site, such as the number of trees or lakes in an area. Soils selected for intensive picnic areas generally have good drainage and are nearly level to gently sloping. They provide good footage and are not subject to flooding or to blowing.

Soil limitations for buildings in recreational areas.—Although detailed onsite investigations are generally required for the selection of a specific building site, table 8 gives preliminary information on suitability of the soils for this use. The ratings apply to seasonal use and year-round use of cottages, washrooms, bathhouses, picnic shelters, and service buildings. Soils that are most desirable for building sites in recreational areas have good drainage, are nearly level to gently sloping, and are not subject to flooding.

Soil limitations for paths and trails.—In table 8 the soils are also rated according to their limitations in use for trails, cross-country hiking, bridle paths, and non-intensive uses that allow for random movement of people. Characteristics considered are degree of wetness, hazard of flooding, degree of slope, and soil texture. Areas that have no limitation to slight limitation for paths and trails generally have good drainage, are not subject to flooding, and are nearly level to rolling. Also the texture of the surface soil is such that footage is good. Soils rated as having severe soil limitations may have a scenic outlook that would make them desirable for paths and trails, but the areas would require much work in preparing and maintaining them for such use.

Soil limitations for intensive camp areas.—The ratings in table 8 that give limitations of the soils for use for intensive camp areas apply to areas suitable for campsites for tents and trailers. Also considered were the

Figure 28.—Wildlife game farm.

accompanying activities for outdoor living. Such areas are used frequently during the camping season. They ought to require little site preparation to be made suitable for unsurfaced parking for cars and camp trailers and for heavy traffic by people, horses, or motor vehicles. The most suitable sites for intensive camp areas have good drainage, are not subject to flooding, and are nearly level to gently sloping. They also provide good footage in all kinds of weather and are not subject to blowing.

Formation, Classification, and Morphology of Soils

In this section the outstanding characteristics of the soils and their relationship to the factors of soil formation are discussed. Then the classification and morphology of the soils are given.

Formation of Soils

Soil is produced by the action of soil-forming processes on material deposited or accumulated by geologic forces. The characteristics of the soil at any given place are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since its accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land, and the drainage that results from it; and (5) the length of time the forces of development have acted on the soil material.

Man has also influenced the development of soils. He has removed the natural vegetation and has used methods of farming that have accelerated erosion and have changed the relief or the effects of relief. Man has also modified the natural differences between soils by adding

TABLE 8.—*Ratings and limitations of soils for recreational purposes*

Soil name and symbol	Intensive play areas	Picnic areas subject to intensive use	Buildings in recreational areas	Paths and trails	Intensive camp areas
Alluvial land (Al)	Very severe: flooded frequently; high water table.	Very severe: flooded frequently; high water table.	Very severe: flooded frequently; high water table.	Very severe: flooded frequently; high water table.	Very severe: flooded frequently.
Beach materials, sandy (Ba).	Very severe: high water table; subject to overflow; loose sand.	Very severe: loose sand; high water table; subject to overflow.	Very severe: high water table; subject to overflow.	Severe: loose sand; subject to overflow.	Very severe: loose sand; subject to overflow.
Becker loam (Bb)	Severe: flooded occasionally; seasonal high water table.	Moderate: flooded occasionally; seasonal high water table.	Very severe: flooded occasionally; seasonal high water table.	Moderate: flooded occasionally.	Severe: flooded occasionally.
Biscay loam (Bc)	Severe: poorly drained; seasonal high water table; sticky when wet; difficult to maintain vegetation if used when wet.	Severe: poorly drained; seasonal high water table; difficult to maintain vegetation if used when wet.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; sticky when wet.	Severe: poorly drained; sticky when wet.
Biscay loam, sandy subsoil variant (Bd).	Severe: poorly drained; seasonal high water table; sticky when wet; difficult to maintain vegetation if used when wet.	Severe: poorly drained; seasonal high water table; difficult to maintain vegetation if used when wet.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; sticky when wet.	Severe: poorly drained; sticky when wet.
Blue Earth silt loam (Be).	Very severe: very poorly drained; seasonally ponded; sticky and slippery when wet.	Very severe: very poorly drained; seasonally ponded; sticky and slippery when wet.	Very severe: very poorly drained; seasonally ponded.	Very severe: very poorly drained; seasonally ponded; sticky and slippery when wet.	Very severe: very poorly drained; seasonally ponded; sticky and slippery when wet.
Braham and Anoka fine sands, 2 to 6 percent slopes, moderately eroded (BhB2).	Moderate: loose sandy footage; subject to blowing; difficult to vegetate; gentle slopes.	Moderate: loose sandy footage; subject to blowing; difficult to vegetate.	None to slight	Moderate: loose sandy footage.	Moderate: loose sandy footage; subject to blowing; difficult to vegetate.
Braham and Anoka fine sands, 6 to 12 percent slopes, moderately eroded (BhC2).	Severe: moderate slopes; loose sandy footage; subject to blowing; difficult to vegetate.	Moderate: loose sand affects traffic; subject to blowing; difficult to vegetate.	Moderate: moderate slopes.	Moderate: loose sandy footage.	Moderate: moderate slopes; loose sandy footage; subject to blowing; difficult to vegetate.
Braham and Anoka fine sands, 12 to 25 percent slopes (BhD).	Severe to very severe: moderately steep to steep slopes; loose sandy footage; subject to blowing; difficult to vegetate.	Severe: moderately steep to steep slopes; loose sandy footage; subject to blowing; difficult to vegetate.	Severe: moderately steep to steep slopes.	Moderate to severe: moderately steep to steep slopes; loose sandy footage.	Severe: moderately steep to steep slopes; loose sandy footage; subject to blowing; difficult to vegetate.
Braham and Anoka loamy fine sands, 0 to 2 percent slopes (BrA).	Moderate: loose sandy footage; subject to blowing; difficult to vegetate.	Moderate: loose sandy footage; subject to blowing; difficult to vegetate.	None to slight	Moderate: loose sandy footage.	Moderate: loose sandy footage; subject to blowing; difficult to vegetate.
Braham and Anoka loamy fine sands, 2 to 6 percent slopes (BrB).	Moderate: gentle slopes; loose sandy footage; subject to blowing; difficult to vegetate.	Moderate: loose sandy footage; subject to blowing; difficult to vegetate.	None to slight	Moderate: loose sandy footage.	Moderate: loose sandy footage; subject to blowing; difficult to vegetate.
Braham and Anoka loamy fine sands, 6 to 12 percent slopes (BrC).	Severe: moderate slopes; loose sandy footage; difficult to vegetate; subject to blowing.	Moderate: loose sandy footage; subject to blowing; difficult to vegetate.	Moderate: moderate slopes.	Moderate: loose sandy footage.	Moderate: moderate slopes; loose sandy footage; subject to blowing; difficult to vegetate.

TABLE 8.—*Ratings and limitations of soils for recreational purposes*—Continued

Soil name and symbol	Intensive play areas	Picnic areas subject to intensive use	Buildings in recreational areas	Paths and trails	Intensive camp areas
Burnsville soils, 0 to 6 percent slopes (BuB).	Moderate: gentle slopes.	None to slight	None to slight	None to slight	None to slight.
Burnsville soils, 2 to 6 percent slopes, moderately eroded (BuB2).	Moderate: gentle slopes.	None to slight	None to slight	None to slight	None to slight.
Burnsville soils, 6 to 12 percent slopes (BuC).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	None to slight	Moderate: moderate slopes.
Burnsville soils, 6 to 12 percent slopes, moderately eroded (BuC2).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	None to slight	Moderate: moderate slopes.
Burnsville soils, 6 to 12 percent slopes, severely eroded (BuC3).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	None to slight	Moderate: moderate slopes.
Burnsville soils, 12 to 18 percent slopes (BuD).	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Moderate: moderately steep slopes.	Severe: moderately steep slopes.
Burnsville soils, 12 to 25 25 percent slopes, severely eroded (BuD3).	Severe to very severe: moderately steep to steep slopes.	Severe to very severe: moderately steep to steep slopes.	Severe: moderately steep to steep slopes.	Moderate to severe: moderately steep to steep slopes.	Severe: moderately steep to steep slopes.
Burnsville soils, 18 to 35 percent slopes (BuE).	Very severe: steep to very steep slopes.	Severe to very severe: steep to very steep slopes.	Severe to very severe: steep to very steep slopes.	Severe to very severe: steep to very steep slopes.	Severe to very severe: steep to very steep slopes.
Burnsville-Hayden complex, 2 to 6 percent slopes (ByB).	Moderate: gentle slopes.	None to slight	None to slight	None to slight	None to slight.
Burnsville-Hayden complex, 2 to 6 percent slopes, moderately eroded (ByB2).	Moderate: gentle slopes.	None to slight	None to slight	None to slight	None to slight.
Burnsville-Hayden complex, 6 to 12 percent slopes (ByC).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	None to slight	Moderate: moderate slopes.
Burnsville-Hayden complex, 6 to 12 percent slopes, moderately eroded (ByC2).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	None to slight	Moderate: moderate slopes.
Burnsville-Hayden complex, 12 to 18 percent slopes (ByD).	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Moderate: moderately steep slopes.	Severe: moderately steep slopes.
Burnsville-Hayden complex, 18 to 35 percent slopes (ByE).	Very severe: steep to very steep slopes.	Severe to very severe: steep to very steep slopes.	Severe to very severe: steep to very steep slopes.	Severe to very severe: steep to very steep slopes.	Severe to very severe: steep to very steep slopes.
Canisteo silty clay loam (Ca).	Severe: poorly drained; seasonally high water table; slippery and sticky when wet; difficult to maintain vegetation if used when wet.	Severe: poorly drained; slippery and sticky when wet.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; slippery and sticky when wet.	Severe: poorly drained; slippery and sticky when wet.
Chelsea fine sand, 2 to 6 percent slopes (ChB).	Moderate: gentle slopes; loose sandy footage; subject to blowing; difficult to vegetate.	Moderate: loose sandy footage; subject to blowing; difficult to vegetate.	None to slight	Moderate: loose sandy footage.	Moderate: loose sandy footage; difficult to vegetate.
Chelsea fine sand, 6 to 12 percent slopes (ChC).	Severe: moderate slopes; loose sandy footage; difficult to vegetate; subject to blowing.	Moderate: loose sandy footage; subject to blowing; difficult to vegetate.	Moderate: moderate slopes.	Moderate: loose sandy footage.	Moderate: loose sandy footage; difficult to vegetate; moderate slopes.
Chelsea fine sand, 12 to 18 percent slopes (ChD).	Severe: moderately steep slopes; loose sandy footage; difficult to vegetate; subject to blowing.	Moderate: loose sandy footage; subject to blowing; difficult to vegetate.	Severe: moderately steep slopes.	Moderate: moderately steep slopes; loose sandy footage.	Severe: moderately steep slopes; loose sandy footage; difficult to vegetate.

TABLE 8.—*Ratings and limitations of soils for recreational purposes*—Continued

Soil name and symbol	Intensive play areas	Picnic areas subject to intensive use	Buildings in recreational areas	Paths and trails	Intensive camp areas
Clayey basin land (Cn)	Severe to very severe: poorly drained and very poorly drained; high water table; seasonally ponded in places; sticky and slippery when wet.	Severe to very severe: poorly drained and very poorly drained; high water table; seasonally ponded in places; sticky and slippery when wet.	Severe to very severe: poorly drained and very poorly drained; high water table; seasonally ponded in places.	Very severe: poorly drained and very poorly drained; sticky and slippery when wet; seasonally ponded in places.	Very severe: poorly drained and very poorly drained; sticky and slippery when wet; seasonally ponded in places.
Comfrey silty clay loam (Co).	Very severe: subject to flooding; poorly drained; high water table; sticky and slippery when wet.	Very severe: subject to flooding; poorly drained; high water table; sticky and slippery when wet.	Very severe: subject to flooding; poorly drained; high water table.	Severe: subject to flooding; poorly drained; sticky and slippery when wet.	Very severe: subject to flooding; poorly drained; sticky and slippery when wet.
Comfrey silty clay loam, depressional (Cp).	Very severe: subject to frequent flooding; poorly drained; high water table; seasonally ponded.	Very severe: subject to frequent flooding; poorly drained; high water table; seasonally ponded.	Very severe: subject to frequent flooding; poorly drained; high water table; seasonally ponded.	Very severe: subject to frequent flooding; poorly drained; seasonally ponded; sticky and slippery when wet.	Very severe: subject to frequent flooding; poorly drained; seasonally ponded; sticky and slippery when wet.
Cordova and Le Sueur silty clay loams (Cs).	Severe: poorly drained and moderately well drained; seasonal high water table; sticky and slippery when wet; difficult to maintain vegetation if used when wet.	Severe: poorly drained and moderately well drained; seasonal high water table; sticky and slippery when wet.	Severe on Cordova, but moderate on Le Sueur; seasonal high water table.	Severe on Cordova, but moderate on Le Sueur; sticky and slippery when wet.	Severe on Cordova but moderate on Le Sueur; sticky and slippery when wet.
Cordova and Webster silty clay loams (Cw).	Severe: poorly drained; seasonal high water table; sticky and slippery when wet; difficult to maintain vegetation if used when wet.	Severe: poorly drained; seasonal high water table; sticky and slippery when wet.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; sticky and slippery when wet.	Severe: poorly drained; sticky and slippery when wet.
Duelm and Watseka soils (De).	Severe: somewhat poorly drained; seasonal high water table; difficult to maintain vegetation if used when wet.	Severe: somewhat poorly drained; seasonal high water table.	Severe: somewhat poorly drained; seasonal high water table.	Moderate: somewhat poorly drained.	Severe: somewhat poorly drained.
Dundas silt loam (Dn)	Severe: somewhat poorly drained to poorly drained; seasonal high water table; slippery and sticky when wet; difficult to maintain vegetation if used when wet.	Severe: somewhat poorly drained to poorly drained; seasonal high water table; slippery and sticky when wet.	Severe: somewhat poorly drained to poorly drained; seasonal high water table.	Severe: somewhat poorly drained to poorly drained; slippery and sticky when wet.	Severe: somewhat poorly drained to poorly drained; slippery and sticky when wet.
Dundas and Ames silt loams (Du).	Severe: somewhat poorly drained to poorly drained; seasonal high water table; slippery and sticky when wet; difficult to maintain vegetation if used when wet.	Severe: somewhat poorly drained to poorly drained; seasonal high water table; slippery and sticky when wet.	Severe: somewhat poorly drained to poorly drained; seasonal high water table.	Severe: somewhat poorly drained to poorly drained; slippery and sticky when wet.	Severe: somewhat poorly drained to poorly drained; slippery and sticky when wet.
Emmert-Milaca complex, 2 to 6 percent slopes (EmB).	Moderate: gentle slopes.	None to slight	None to slight	None to slight	None to slight
Emmert-Milaca complex, 6 to 12 percent slopes (EmC).	Severe: Moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	None to slight	Moderate: moderate slopes.

TABLE 8.—*Ratings and limitations of soils for recreational purposes*—Continued

Soil name and symbol	Intensive play areas	Picnic areas subject to intensive use	Buildings in recreational areas	Paths and trails	Intensive camp areas
Emmert-Milaca complex, 12 to 18 percent slopes (EmD).	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Moderate: moderately steep slopes.	Severe: moderately steep slopes.
Emmert-Milaca complex, 18 to 35 percent slopes (EmE).	Very severe: moderately steep to very steep slopes.	Severe to very severe: moderately steep to very steep slopes.	Severe to very severe: moderately steep to very steep slopes.	Severe to very severe: moderately steep to very steep slopes.	Severe to very severe: moderately steep to very steep slopes.
Etherville loam, 0 to 2 percent slopes (EsA).	None to slight.	None to slight.	None to slight.	None to slight.	None to slight.
Estherville loam, 2 to 6 percent slopes (EsB).	Moderate: gentle slopes.	None to slight.	None to slight.	None to slight.	None to slight.
Estherville loam, 2 to 6 percent slopes, moderately eroded (EsB2).	Moderate: gentle slopes.	None to slight.	None to slight.	None to slight.	None to slight.
Estherville loam, 6 to 12 percent slopes (EsC).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	None to slight.	Moderate: moderate slopes.
Estherville loam, 6 to 12 percent slopes, moderately eroded (EsC2).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	None to slight.	Moderate: moderate slopes.
Estherville sandy loam, 0 to 2 percent slopes (EtA).	None to slight.	None to slight.	None to slight.	None to slight.	None to slight.
Estherville sandy loam, 2 to 6 percent slopes (EtB).	Moderate: gentle slopes.	None to slight.	None to slight.	None to slight.	None to slight.
Estherville sandy loam, 2 to 6 percent slopes, moderately eroded (EtB2).	Moderate: gentle slopes.	None to slight.	None to slight.	None to slight.	None to slight.
Estherville sandy loam, 6 to 12 percent slopes (EtC).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	None to slight.	Moderate: moderate slopes.
Estherville sandy loam, 6 to 12 percent slopes, moderately eroded slopes (EtC2).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	None to slight.	Moderate: moderate slopes.
Estherville sandy loam, 12 to 18 percent slopes (EtD).	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Moderate: moderately steep slopes.	Severe: moderately steep slopes.
Estherville sandy loam, 18 to 25 percent slopes (EtE).	Very severe: steep slopes.	Severe: steep slopes.	Severe: steep slopes.	Severe: steep slopes.	Severe: steep slopes.
Estherville soils, 6 to 12 percent slopes, severely eroded (EvC3).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	None to slight.	Moderate: moderate slopes.
Estherville soils, 12 to 25 percent slopes, severely eroded (EvE3).	Severe to very severe: moderately steep to steep slopes.	Severe to very severe: moderately steep to steep slopes.	Severe: moderately steep to steep slopes.	Severe: moderately steep to steep slopes.	Moderate to severe: moderately steep to very steep slopes.
Fairhaven silt loam, 0 to 2 percent slopes (FaA).	Moderate: slippery when wet.	Moderate: slippery when wet.	None to slight.	Moderate: slippery when wet.	Moderate: slippery when wet.
Fairhaven silt loam, 2 to 6 percent slopes (FaB).	Moderate: gentle slopes; slippery when wet.	Moderate: slippery when wet.	None to slight.	Moderate: slippery when wet.	Moderate: slippery when wet.
Fairhaven silt loam, 2 to 6 percent slopes, moderately eroded (FaB2).	Moderate: gentle slopes; slippery when wet.	Moderate: slippery when wet.	None to slight.	Moderate: slippery when wet.	Moderate: slippery when wet.
Fairhaven silt loam, 6 to 12 percent slopes, moderately eroded (FaC2).	Severe: moderate slopes; slippery when wet.	Moderate: moderate slopes; slippery when wet.	Moderate: moderate slopes.	Moderate: slippery when wet.	Moderate: slippery when wet; moderate slopes.

TABLE 8.—*Ratings and limitations of soils for recreational purposes*—Continued

Soil name and symbol	Intensive play areas	Picnic areas subject to intensive use	Buildings in recreational areas	Paths and trails	Intensive camp areas
Glencoe silty clay loam (Gc).	Very severe: very poorly drained; high water table; seasonally ponded; sticky and slippery when wet.	Very severe: very poorly drained; high water table; seasonally ponded; sticky and slippery when wet.	Very severe: very poorly drained; high water table; seasonally ponded; sticky and slippery when wet.	Very severe: very poorly drained; high water table; seasonally ponded; sticky and slippery when wet.	Very severe: very poorly drained; high water table; seasonally ponded; sticky and slippery when wet.
Guckeen silty clay loam, 0 to 2 percent slopes (GuA).	Moderate: moderately well drained to somewhat poorly drained; fairly high seasonal water table; sticky and slippery when wet; difficult to maintain vegetation if used when wet.	Moderate: moderately well drained to somewhat poorly drained; sticky and slippery when wet.	Moderate: fairly high seasonal water table.	Moderate: moderately well drained to somewhat poorly drained; sticky and slippery when wet.	Moderate: moderately well drained to somewhat poorly drained; sticky and slippery when wet.
Guckeen silty clay loam, 2 to 6 percent slopes (GuB).	Moderate: gentle slopes; moderately well drained to somewhat poorly drained; fairly high seasonal water table; sticky and slippery when wet.	Moderate: moderately well drained to somewhat poorly drained; sticky and slippery when wet.	Moderate: fairly high seasonal water table.	Moderate: moderately well drained to somewhat poorly drained; sticky and slippery when wet.	Moderate: moderately well drained to somewhat poorly drained; sticky and slippery when wet.
Guckeen silty clay loam, 6 to 12 percent slopes (GuC).	Severe: moderate slopes; fairly high seasonal water table; sticky and slippery when wet.	Moderate: moderately well drained to somewhat poorly drained; sticky and slippery when wet.	Moderate: moderate slopes; fairly high seasonal water table.	Moderate: moderately well drained to somewhat poorly drained; sticky and slippery when wet.	Moderate: moderately well drained to somewhat poorly drained; sticky and slippery when wet; moderate slopes.
Hayden clay loam, 6 to 12 percent slopes, severely eroded (HaC3).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	Moderate: sticky when wet.	Moderate: moderate slopes; sticky and slippery when wet.
Hayden clay loam, 12 to 18 percent slopes, severely eroded (HaD3).	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Moderate: moderately steep slopes.	Severe: moderately steep slopes; sticky and slippery when wet.
Hayden fine sandy loam, 0 to 2 percent slopes (HdA).	None to slight	None to slight	None to slight	None to slight	None to slight.
Hayden fine sandy loam, 2 to 6 percent slopes (HdB).	Moderate: gentle slopes.	None to slight	None to slight	None to slight	None to slight.
Hayden fine sandy loam, 2 to 6 percent slopes, moderately eroded (HdB2).	Moderate: gentle slopes.	None to slight	None to slight	None to slight	None to slight.
Hayden fine sandy loam, 6 to 12 percent slopes (HdC).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	None to slight	Moderate: Moderate slopes.
Hayden fine sandy loam, 6 to 12 percent slopes, moderately eroded (HdC2).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	None to slight	Moderate: moderate slopes.
Hayden fine sandy loam, 12 to 18 percent slopes (HdD).	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Moderate: moderately steep slopes.	Severe: moderately steep slopes.
Hayden fine sandy loam, 12 to 18 percent slopes, moderately eroded (HdD2).	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Moderate: moderately steep slopes.	Moderate: moderately steep slopes.

TABLE 8.—*Ratings and limitations of soils for recreational purposes*—Continued

Soil name and symbol	Intensive play areas	Picnic areas subject to intensive use	Buildings in recreational areas	Paths and trails	Intensive camp areas
Hayden loam, 2 to 6 percent slopes (HlB).	Moderate: gentle slopes.	None to slight.	None to slight.	None to slight.	None to slight.
Hayden loam, 2 to 6 percent slopes, moderately eroded (HlB2).	Moderate: gentle slopes.	None to slight.	None to slight.	Moderate: sticky when wet.	Moderate: sticky when wet.
Hayden loam, 6 to 12 percent slopes (HlC).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	None to slight.	Moderate: moderate slopes; sticky when wet.
Hayden loam, 6 to 12 percent slopes, moderately eroded (HlC2).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	Moderate: sticky when wet.	Moderate: moderate slopes; sticky when wet.
Hayden loam, 12 to 18 percent slopes (HlD).	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Moderate: moderately steep slopes; sticky when wet.	Moderate: moderately steep slopes; sticky when wet.
Hayden loam, 12 to 18 percent slopes, moderately eroded (HlD2).	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Moderate: moderately steep slopes; sticky when wet.	Moderate: moderately steep slopes; sticky when wet.
Hayden loam, 18 to 25 percent slopes (HlE).	Very severe: steep slopes.	Severe: steep slopes.	Severe: steep slopes.	Severe: steep slopes; sticky when wet.	Severe: steep slopes; sticky when wet.
Hayden loam, 25 to 35 percent slopes (HlF).	Very severe: very steep slopes.	Very severe: very steep slopes.	Very severe: very steep slopes.	Very severe: very steep slopes; sticky when wet.	Very severe: very steep slopes; sticky when wet.
Hayden soils, 18 to 25 percent slopes, severely eroded (HnE3).	Very severe: steep slopes.	Very severe: steep slopes.	Severe: steep slopes.	Severe: steep slopes; sticky when wet.	Severe: steep slopes; sticky when wet.
Hubbard loamy sand, 0 to 2 percent slopes (HrA).	Moderate: loose sandy footage; subject to blowing; difficult to vegetate.	Moderate: loose sandy footage; subject to blowing; difficult to vegetate.	None to slight.	Moderate: loose sandy footage.	Moderate: loose sandy footage; difficult to vegetate.
Hubbard loamy sand, 2 to 6 percent slopes (HrB).	Moderate: gentle slopes; loose sandy footage; subject to blowing; difficult to vegetate.	Moderate: loose sandy footage; subject to blowing; difficult to vegetate.	None to slight.	Moderate: loose sandy footage.	Moderate: loose sandy footage; difficult to vegetate.
Hubbard loamy sand, 2 to 6 percent slopes, moderately eroded (HrB2).	Moderate: gentle slopes; loose sandy footage; subject to blowing; difficult to vegetate.	Moderate: loose sandy footage; subject to blowing; difficult to vegetate.	None to slight.	Moderate: loose sandy footage.	Moderate: loose sandy footage. difficult to vegetate.
Hubbard loamy sand, 6 to 12 percent slopes (HrC).	Severe: moderate slopes; loose sandy footage; subject to blowing; difficult to vegetate.	Moderate: loose sandy footage; subject to blowing; difficult to vegetate.	Moderate: moderate slopes.	Moderate: loose sandy footage.	Moderate: moderate slopes; loose sandy footage; difficult to vegetate.
Hubbard loamy sand, 6 to 12 percent slopes, moderately eroded (HrC2).	Severe: moderate slopes; loose sandy footage; subject to blowing; difficult to vegetate.	Moderate: loose sandy footage; subject to blowing; difficult to vegetate.	Moderate: moderate slopes.	Moderate: loose sandy footage.	Moderate: moderate slopes; loose sandy footage; difficult to vegetate.
Hubbard loamy sand, 12 to 35 percent slopes, moderately eroded (HrE2).	Severe to very severe: moderately steep to very steep slopes; loose sandy footage; subject to blowing; difficult to vegetate.	Severe to very severe: moderately steep to very steep slopes; loose sandy footage; subject to blowing; difficult to vegetate.	Moderate to very severe: moderate to very steep slopes.	Moderate to very severe: moderate to very steep slopes; loose sandy footage.	Moderate to very severe: moderate to very steep slopes; loose sandy footage; difficult to vegetate.
Hubbard loamy sand, gravelly subsoil variant, 0 to 2 percent slopes (HsA).	Moderate: loose sandy footage; subject to blowing; difficult to vegetate.	Moderate: loose sandy footage; subject to blowing; difficult to vegetate.	None to slight.	None to slight.	Moderate: loose sandy footage; difficult to vegetate.

TABLE 8.—*Ratings and limitations of soils for recreational purposes*—Continued

Soil name and symbol	Intensive play areas	Picnic areas subject to intensive use	Buildings in recreational areas	Paths and trails	Intensive camp areas
Hubbard loamy sand, gravelly subsoil variant, 2 to 6 percent slopes (HsB).	Moderate: gentle slopes; loose sandy footage; subject to blowing; difficult to vegetate.	Moderate: loose sandy footage; subject to blowing; difficult to vegetate.	None to slight	None to slight	Moderate: loose sandy footage; difficult to vegetate.
Hubbard loamy sand, gravelly subsoil variant, 2 to 6 percent slopes, moderately eroded (HsB2).	Moderate: gentle slopes; loose sandy footage; subject to blowing; difficult to vegetate.	Moderate: loose sandy footage; subject to blowing; difficult to vegetate.	None to slight	None to slight	Moderate: loose sandy footage; difficult to vegetate.
Hubbard loamy sand, gravelly subsoil variant, 6 to 12 percent slopes (HsC).	Severe: moderate slopes; loose sandy footage; subject to blowing; difficult to vegetate.	Moderate: loose sandy footage; subject to blowing; difficult to vegetate.	Moderate: moderate slopes.	None to slight	Severe: moderate slopes; loose sandy footage; difficult to vegetate.
Hubbard sandy loam, 0 to 2 percent slopes (HuA).	None to slight	None to slight	None to slight	None to slight	None to slight.
Hubbard sandy loam, 0 to 2 percent slopes, moderately eroded (HuA2).	None to slight	None to slight	None to slight	None to slight	None to slight.
Hubbard sandy loam, 2 to 6 percent slopes (HuB).	Moderate: gentle slopes.	None to slight	None to slight	None to slight	None to slight.
Hubbard sandy loam, 2 to 6 percent slopes, moderately eroded (HuB2).	Moderate: gentle slopes.	None to slight	None to slight	None to slight	None to slight.
Hubbard sandy loam, 6 to 12 percent slopes (HuC).	Severe: moderate slopes.	Moderate: moderate slopes; subject to severe erosion if vegetation is not maintained.	Moderate: moderate slopes.	None to slight	Moderate: moderate slopes.
Hubbard sandy loam, 6 to 12 percent slopes, moderately eroded (HuC2).	Severe: moderate slopes.	Moderate: moderate slopes; subject to severe erosion if vegetation is not maintained.	Moderate: moderate slopes.	None to slight	Moderate: moderate slopes.
Lake borders (Lb)	Very severe: poorly drained to very poorly drained; high water table; sticky and slippery when wet; subject to overflow.	Very severe: poorly drained to very poorly drained; high water table; sticky and slippery when wet; subject to overflow.	Very severe: poorly drained to very poorly drained; high water table; subject to overflow; sticky and slippery when wet.	Very severe: poorly drained to very poorly drained; subject to overflow; sticky and slippery when wet.	Very severe: poorly drained to very poorly drained; subject to overflow; sticky and slippery when wet.
Lester clay loam, 6 to 12 percent slopes, severely eroded (LcC3).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	Moderate: sticky when wet.	Moderate: moderate slopes; sticky when wet.
Lester clay loam, 12 to 18 percent slopes, severely eroded (LcD3).	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Moderate: moderately steep slopes; sticky when wet.	Moderate: moderately steep slopes; sticky when wet.
Lester clay loam, 18 to 25 percent slopes, severely eroded (LcE3).	Very severe: steep slopes.	Severe: steep slopes.	Severe: steep slopes.	Severe: steep slopes; sticky when wet.	Severe: steep slopes; sticky when wet.
Lester loam, 2 to 6 percent slopes (LeB).	Moderate: gentle slopes.	None to slight	None to slight	None to slight	None to slight.
Lester loam, 2 to 6 percent slopes, moderately eroded (LeB2).	Moderate: gentle slopes.	None to slight	None to slight	Moderate: sticky when wet.	Moderate: sticky when wet.
Lester loam, 6 to 12 percent slopes (LeC).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	None to slight	Moderate: moderate slopes.

TABLE 8.—*Ratings and limitations of soils for recreational purposes*—Continued

Soil name and symbol	Intensive play areas	Picnic areas subject to intensive use	Buildings in recreational areas	Paths and trails	Intensive camp areas
Lester loam, 6 to 12 percent slopes, moderately eroded (LeC2).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	Moderate: sticky when wet.	Moderate: moderate slopes; sticky when wet.
Lester loam, 12 to 18 percent slopes (LeD).	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Moderate: moderately steep slopes.	Moderate: moderately steep slopes.
Lester loam, 18 to 25 percent slopes (LeE).	Very severe: steep slopes.	Severe: steep slopes.	Severe: steep slopes.	Severe: steep slopes.	Severe: steep slopes.
Lester loam, 25 to 35 percent slopes (LeF).	Very severe: very steep slopes.	Very severe: very steep slopes.	Very severe: very steep slopes.	Very severe: very steep slopes.	Very severe: very steep slopes.
Lester silt loam, silty variant, 0 to 2 percent slopes (LrA).	Moderate: slippery when wet.	Moderate: slippery when wet.	None to slight	Moderate: slippery when wet.	Moderate: slippery when wet.
Lester silt loam, silty variant, 2 to 6 percent slopes (LrB).	Moderate: gentle slopes; slippery when wet.	Moderate: slippery when wet.	None to slight	Moderate: slippery when wet.	Moderate: slippery when wet.
Lester silt loam, silty variant, 2 to 6 percent slopes, moderately eroded (LrB2).	Moderate: gentle slopes; slippery when wet.	Moderate: slippery when wet.	None to slight	Moderate: slippery when wet.	Moderate: slippery when wet.
Lester silt loam, silty variant, 6 to 12 percent slopes, moderately eroded (LrC2).	Severe: moderate slopes; slippery when wet.	Moderate: moderate slopes; slippery when wet.	Moderate: moderate slopes.	Moderate: slippery when wet.	Moderate: slippery when wet.
Lester-Estherville complex, 2 to 6 percent slopes (LtB).	Moderate: gentle slopes.	None to slight	None to slight	None to slight	None to slight.
Lester-Estherville complex, 2 to 6 percent slopes, moderately eroded (LtB2).	Moderate: gentle slopes.	None to slight	None to slight	None to slight	None to slight.
Lester-Estherville complex, 6 to 12 percent slopes (LtC).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	None to slight	Moderate: moderate slopes.
Lester-Estherville complex, 12 to 18 percent slopes (LtD).	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Moderate: moderately steep slopes.	Moderate: moderately steep slopes.
Le Sueur clay loam, 0 to 2 percent slopes (LuA).	Moderate: moderately well drained to somewhat poorly drained; fairly high seasonal water table; sticky and slippery when wet; difficult to maintain vegetation if used when wet.	Moderate: moderately well drained to somewhat poorly drained; sticky and slippery when wet.	Moderate: moderately well drained to somewhat poorly drained; fairly high seasonal water table.	Moderate: moderately well drained to somewhat poorly drained; sticky and slippery when wet.	Moderate: moderately well drained to somewhat poorly drained; sticky and slippery when wet.
Le Sueur clay loam, 2 to 6 percent slopes (LuB).	Moderate: moderately well drained to somewhat poorly drained; fairly high seasonal water table; difficult to maintain vegetation if used when wet.	Moderate: moderately well drained to somewhat poorly drained; sticky and slippery when wet.	Moderate: moderately well drained to somewhat poorly drained; fairly high seasonal water table.	Moderate: moderately well drained to somewhat poorly drained; sticky and slippery when wet.	Moderate: moderately well drained to somewhat poorly drained; sticky and slippery when wet.
Marna silty clay loam (Ma).	Severe: poorly drained; high water table; sticky and slippery when wet; difficult to maintain vegetation if used when wet.	Severe: poorly drained; high water table; sticky and slippery.	Severe: poorly drained; high water table.	Severe: poorly drained; sticky and slippery when wet.	Severe: poorly drained; sticky and slippery when wet.
Marsh (Mh)	Very severe: very poorly drained; high water table; ponded.	Very severe: very poorly drained; high water table; ponded.	Very severe: very poorly drained; high water table; ponded.	Very severe: very poorly drained; high water table; ponded.	Very severe: very poorly drained; high water table; ponded.

TABLE 8.—*Ratings and limitations of soils for recreational purposes*—Continued

Soil name and symbol	Intensive play areas	Picnic areas subject to intensive use	Buildings in recreational areas	Paths and trails	Intensive camp areas
Milaca loam, 2 to 6 percent slopes, moderately eroded (MlB2).	Moderate: gentle slopes.	None to slight	None to slight	Moderate: sticky when wet.	Moderate: sticky and slippery when wet.
Muck, deep (Mu)	Very severe: very poorly drained; high water table; seasonally ponded.	Very severe: very poorly drained; high water table; seasonally ponded.	Very severe: very poorly drained; high water table; seasonally ponded.	Very severe: very poorly drained; seasonally ponded.	Very severe: very poorly drained; seasonally ponded.
Nessel silt loam, 0 to 2 percent slopes (NeA).	Moderate: moderately well drained; fairly high seasonal water table; slippery when wet.	Moderate: moderately well drained; slippery when wet.	Moderate: moderately well drained; fairly high seasonal water table.	Moderate: moderately well drained; slippery when wet.	Moderate: moderately well drained; slippery when wet.
Nessel silt loam, 2 to 6 percent slopes (NeB).	Moderate: gentle slopes; moderately well drained; fairly high seasonal water table; slippery when wet.	Moderate: moderately well drained; slippery when wet.	Moderate: moderately well drained; fairly high seasonal water table.	Moderate: moderately well drained; slippery when wet.	Moderate: moderately well drained; slippery when wet.
Peat and muck, deep (Pa).	Very severe: very poorly drained; high water table; seasonally ponded.	Very severe: very poorly drained; high water table; seasonally ponded.	Very severe: very poorly drained; high water table; seasonally ponded.	Very severe: very poorly drained; seasonally ponded.	Very severe: very poorly drained; seasonally ponded.
Peat and muck, shallow over loam (Pm).	Very severe: very poorly drained; high water table; seasonally ponded.	Very severe: very poorly drained; high water table; seasonally ponded.	Very severe: very poorly drained; high water table; seasonally ponded.	Very severe: very poorly drained; seasonally ponded.	Very severe: very poorly drained; seasonally ponded.
Peat and muck, shallow over sand (Ps).	Very severe: very poorly drained; high water table; seasonally ponded.	Very severe: very poorly drained; high water table; seasonally ponded.	Very severe: very poorly drained; high water table; seasonally ponded.	Very severe: very poorly drained; seasonally ponded.	Very severe: very poorly drained; seasonally ponded.
Rasset and Hubbard soils, 0 to 6 percent slopes (RhA).	None to slight	None to slight	None to slight	None to slight	None to slight.
Rasset and Hubbard soils 2 to 6 percent slopes (RhB).	Moderate: gentle slopes.	None to slight	None to slight	None to slight	None to slight.
Rasset and Hubbard soils, 2 to 6 percent slopes, moderately eroded (RhB2).	Moderate: gentle slopes.	None to slight	None to slight	None to slight	None to slight.
Rasset and Hubbard soils, 6 to 12 percent slopes (RhC).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	None to slight	Moderate: moderate slopes.
Rasset and Hubbard soils, 6 to 12 percent slopes, moderately eroded (RhC2).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	None to slight	Moderate: moderate slopes.
Salida gravelly sandy loam, 2 to 6 percent slopes (SaB).	Moderate: gentle slopes; loose sandy footage; difficult to vegetate; subject to blowing.	Moderate: loose sandy footage; difficult to vegetate; subject to blowing.	None to slight	None to slight	Moderate: subject to blowing; difficult to vegetate.
Salida gravelly sandy loam, 6 to 12 percent slopes (SaC).	Severe: moderate slopes; difficult to vegetate.	Moderate: moderate slopes; difficult to vegetate.	Moderate: moderate slopes.	None to slight	Moderate: moderate slopes; difficult to vegetate.
Salida gravelly sandy loam, 12 to 35 percent slopes (SaE).	Severe to very severe: moderately steep to very steep slopes; difficult to vegetate.	Severe to very severe: moderately steep to very steep slopes.	Severe to very severe: moderately steep to very steep slopes.	Moderate to very severe: moderately steep to very steep slopes.	Moderate to very severe: moderately steep to very steep slopes; difficult to vegetate.
Salida complex, 2 to 6 percent slopes (ScB).	Moderate: gently sloping; difficult to vegetate.	Moderate: difficult to vegetate.	None to slight	None to slight	Moderate: difficult to vegetate.

TABLE 8.—*Ratings and limitations of soils for recreational purposes*—Continued

Soil name and symbol	Intensive play areas	Picnic areas subject to intensive use	Buildings in recreational areas	Paths and trails	Intensive camp areas
Salida complex, 6 to 12 percent slopes (ScC).	Severe: moderate slopes; difficult to vegetate.	Moderate: difficult to vegetate.	Moderate: moderate slopes.	None to slight	Moderate: moderate slopes; difficult to vegetate.
Salida complex, 12 to 35 percent slopes (ScE).	Severe to very severe: moderately steep to very steep slopes; difficult to vegetate.	Severe to very severe: moderately steep to very steep slopes; difficult to vegetate.	Severe to very severe: moderately steep to very steep.	Moderate to very severe: moderately steep to very steep slopes.	Moderate to very severe: moderately steep to very steep slopes.
Sattre silt loam, silty variant, 0 to 2 percent slopes (SeA).	Moderate: slippery when wet.	Moderate: slippery when wet.	None to slight	Moderate: slippery when wet.	Moderate: slippery when wet.
Sattre silt loam, silty variant, 2 to 6 percent slopes (SeB).	Moderate: slippery when wet; gentle slopes.	Moderate: slippery when wet.	None to slight	Moderate: slippery when wet.	Moderate: slippery when wet.
Storden-Lester loams, 6 to 12 percent slopes, moderately eroded (SlC2).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	Moderate: sticky when wet.	Moderate: moderate slopes; sticky when wet.
Storden-Lester loams, 12 to 18 percent slopes, moderately eroded (SlD2).	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Moderate: moderately steep slopes; sticky when wet.	Moderate: moderately steep slopes; sticky when wet.
Storden-Lester loams, 18 to 25 percent slopes, moderately eroded (SlE2).	Very severe: steep slopes.	Severe: steep slopes.	Severe: steep slopes.	Severe: steep slopes; sticky when wet.	Severe: steep slopes; sticky when wet.
Storden-Lester soils, 6 to 12 percent slopes, severely eroded (StC3).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	Moderate: steep slopes; sticky when wet.	Moderate: steep slopes; sticky when wet.
Storden-Lester soils, 12 to 18 percent slopes, severely eroded (StD3).	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Severe: moderately steep slopes.	Moderate: moderately steep slopes; sticky when wet.	Moderate: moderately steep slopes; sticky when wet.
Talcot clay loam (Tc)	Very severe: very poorly drained; high water table; seasonally ponded; sticky and slippery when wet.	Very severe: very poorly drained; high water table; seasonally ponded; sticky and slippery when wet.	Very severe: very poorly drained; high water table; seasonally ponded; sticky and slippery when wet.	Very severe: very poorly drained; seasonally ponded; sticky and slippery when wet.	Very severe: very poorly drained; seasonally ponded; sticky and slippery when wet.
Terril loam, occasionally flooded, 0 to 2 percent slopes (TeA).	Severe: occasionally flooded; fairly high seasonal water table.	Severe: flooded occasionally; fairly high seasonal water table.	Severe: flooded occasionally; fairly high seasonal water table.	Moderate: flooded occasionally.	Severe: flooded occasionally.
Terril loam, sandy substratum, 0 to 2 percent slopes (TlA).	Severe: moderately well drained to somewhat poorly drained; fairly high seasonal water table.	Moderate: moderately well drained to somewhat poorly drained; fairly high seasonal water table.	Moderate: moderately well drained to somewhat poorly drained; fairly high seasonal water table.	Moderate: moderately well drained to somewhat poorly drained.	Severe: moderately well drained to somewhat poorly drained.
Terril soils, 2 to 6 percent slopes (TsB).	Severe: moderately well drained; fairly high seasonal water table.	Moderate: moderately well drained; fairly high seasonal water table.	Moderate: moderately well drained; fairly high seasonal water table.	None to slight	Moderate: moderately well drained.
Wadena loam, 0 to 2 percent slopes (WaA).	None to slight	None to slight	None to slight	None to slight	None to slight.
Wadena loam, 2 to 6 percent slopes (WaB).	Moderate: gentle slopes.	None to slight	None to slight	None to slight	None to slight.
Wadena loam, 2 to 6 percent slopes, moderately eroded (WaB2).	Moderate: gentle slopes.	None to slight	None to slight	None to slight	None to slight.
Wadena loam, 6 to 12 percent slopes, moderately eroded (WaC2).	Severe: moderate slopes.	Moderate: moderate slopes.	Moderate: moderate slopes.	None to slight	Moderate: moderate slopes.
Webster silty clay loam, silty variant (We).	Severe: poorly drained; high water table; sticky and slippery when wet; difficult to maintain vegetation if used when wet.	Severe: poorly drained; high water table; sticky and slippery when wet.	Severe: poorly drained; high water table; sticky and slippery when wet.	Severe: poorly drained; sticky and slippery when wet.	Severe: poorly drained; sticky and slippery when wet.

materials that improved the fertility of some soils. He also lowered fertility of some soils by removing crops without replacing plant nutrients.

Climate and vegetation are the active factors of soil genesis. They act on the parent material accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. The kind of parent material also affects the kind of profile that can be formed and, in extreme cases, dominates it entirely. Finally time is needed for the changing of the parent material into a soil profile. It may be much or little, but some time is always required for horizon differentiation, and generally a long time is required for the development of distinct horizons.

The individual factors of soil formation are discussed separately in the paragraphs that follow. It is the interaction of all these factors, however, that determine the nature of the soil profile. Few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil formation are unknown.

Parent material

Wright County is in a glaciated region characterized by young plains, moraines, lakes, and lacustrine beds. Glacial till, glacial outwash, and glaciolacustrine material therefore make up much of the parent material of soils in this county. Many of the soils, however, formed in organic material or in recent alluvium and colluvium. The differences in these parent materials account for many of the differences among the soils in the county. In the paragraphs that follow, the different kinds of parent material are described.

Glacial till.—Parts of three continental glaciers, the Nebraskan, the Kansan, and the Wisconsin covered Wright County at various times. The Nebraskan and Kansan occurred about 1 to 2 million years ago. The most recent, the Wisconsin, terminated about 10,000 years ago. Material deposited by the Nebraskan and Kansan ice sheets is buried deep under younger deposits from the Wisconsin glacier and has no influence on soils in the county.

Four kinds of till were deposited in the county by the Wisconsin glacier through the Iowan lobe, the Cary Keewatin substage, the Cary Patrician lobe, and the Mankato substage, in order from the oldest to the most recent.

The Iowan lobe covered the entire county. The gray drift deposited by this lobe later was covered by ice of the Cary Keewatin substage. This substage left grayish or yellowish-brown till that is silty or clayey and is highly calcareous. Following the Cary Keewatin substage, the Cary Patrician lobe passed over the northeastern part of the county. A small area of till from this lobe is exposed in Silver Creek Township. The drift from the Cary Patrician lobe is red and sandy. It contains less clay than drift from the Cary Keewatin substage and has no limestone pebbles or only a few of them. Also deposited by the Cary Patrician substage was the St. Croix moraine, part of which is in the northwestern part of the county in an area of steep hills and depressions.

The Mankato substage is believed to have covered all of the county. Most of the till in the county is from this substage and is the source of parent material of most of the soils. The till deposited by the Mankato substage is yellowish-brown or light olive-brown loam to clay loam slightly mottled with pale yellow or gray. It is calcareous and contains many pebbles of limestone from the Manitoba escarpment and many fragments of Cretaceous shale from the Red River Valley. The till contains much calcium carbonate and effervesces strongly if hydrochloric acid is applied. Most soils formed in this till are leached to a depth of less than 4 feet. Even though the till was derived mostly from limestone and calcareous shale, it includes enough granitic material and material from sandstone to provide soils that have abundant minerals and a loam to clay loam texture. The chief soils formed in till from the Mankato substage are of the Lester, Hayden, and Le Sueur series.

Glacial outwash.—Deposits of glacial outwash were originally carried by glaciers, but the material was swept out, sorted, and deposited beyond the front of the glacier by streams of melt water. In Wright County the outwash consists mainly of outwash plains formed by the Mankato substage of the Wisconsin glaciation. Most areas are nearly level to undulating, but some rolling to hilly areas of "pitted outwash" are in the northwestern part of the county. The pitted appearance is the result of depressions that were blocked with ice, which kept them from filling with outwash from the glacier. Then when the ice melted, a depression, or pit, was left. Most of the outwash material is stratified and well sorted, but in many areas near the moraines it is poorly sorted.

The largest areas of glacial outwash in the county extend from Monticello to Clearwater and are 75 to 80 feet above the Mississippi River. The stratified sand, gravel, and finer materials making up the outwash were carried into depressions and old channels of the Mississippi River by floodwater from the melting ice sheet at the end of the glacial period. The outwash was deposited in the same manner that floods each spring now add sediments to the bottom lands, except that the floods from the glacier lasted all summer. Smaller areas of glacial outwash border the branches of the Crow River and Silver Creek.

Because the kinds of materials in the glacial outwash vary greatly, many different soils formed in this parent material. Soils formed in outwash range from fine sand to silty clay in the upper part. Depth to sand and gravel varies, but generally is within 4 feet. In small areas in some old drainageways, the soil material includes deep deposits of slack water clay. In many places shaly material is imbedded in the coarse-textured outwash deposited along the Crow River. Large stones are mixed in the outwash in some places. Depth to free lime carbonates ranges from 3 to more than 6 feet. The Estherville, Hubbard, and Wadena series are some of the major soils in the county that formed in glacial outwash.

Glaciolacustrine material.—Material of glacial origin that has been reworked and laid down in glacial lakes is termed glaciolacustrine. The material ranges from sand to clay, and in many places it is interbedded or laminated.

In this county the largest areas of glaciolacustrine material are along the shores of Cedar, Clearwater, John,

and Union Lakes in the northwestern part of the county. The areas are about one-fourth of a mile wide and are on the southeastern side of the lakes. Soils of the Guckeen series are examples of soils formed in lacustrine material.

Organic material.—Soils consisting of organic material are in the many depressions, drainageways, and old lake bottoms that occur throughout the county. The water table is high in these areas, and the areas therefore are always wet. Consequently decomposition is reduced and organic material accumulates more rapidly than it decomposes. The soils here consist mainly of the remains of aquatic reeds, grasses, and sedges in peaty deposits.

If the organic remains that make up the soil material are sufficiently fresh and intact for identification of plant forms, the organic material is called peat. If the material is sufficiently decomposed that plant forms cannot be recognized, the material is termed muck. Plant remains in various stages of decomposition are the parent material of Peat and muck soils.

Alluvium.—The soils on old stream terraces and on bottom lands of present streams that normally are flooded are made up chiefly of alluvium. The largest areas of soils formed in alluvium are on bottom lands of the Mississippi and Crow Rivers. The sediments vary greatly in texture and generally are stratified. They also vary greatly in color, reaction, and drainage. The areas are flooded at various times, and fresh sediments are added. The deposits therefore have not been in place long enough for a soil profile to have formed, though the material is mottled in places. The Becker and Comfrey soils are examples of soils that formed in alluvium.

Colluvium.—Soils at the base of slopes and in channels and slight depressions consist chiefly of colluvium. The material was deposited through creep and local wash. In the glacial uplands, the colluvium washed or rolled down slope onto glacial till. On the outwash plains the colluvium is in channels and shallow depressions underlain by glacial sand and gravel.

The colluvium varies in thickness, and soils formed in it range from loamy sand to silty clay loam in texture. They are slightly alkaline to medium acid and have good to somewhat poor drainage. In this county soils of the Terril series formed in colluvium.

Climate

Climate, as a genetic factor, affects the physical, chemical, and biological relationships in the soil profile, chiefly through the influence of precipitation and temperature. Water from rainfall and melting snow dissolves minerals, supports biological activity, and transports mineral and organic residues through the soil profile. The amount of water that percolates through the soil at a given point depends upon the amount and intensity of rainfall, relative humidity, length of the frost-free period, soil permeability, and position on the landscape. Temperature influences the kinds and growth of organisms and the speed of physical and chemical reactions in the soils.

Wright County has a cool, subhumid, continental type of climate that varies widely in temperature from summer to winter. The soils generally are frozen to a depth of 3 to 5 feet for 4 to 5 months of the year. The depth to which frost penetrates depends mostly on the amount of snow received late in fall or early in winter. The snow cover helps to prevent water erosion and slows down denitrification processes. During winter the soil-forming forces are largely dormant, though some alternate freezing and thawing takes place.

The climate is essentially uniform throughout the county, but differences in vegetation, soil materials, and relief can cause variations in the microclimate. Soils in the prairie regions are exposed to a greater variation in temperature than those in the forest regions. On the gently rolling or undulating uplands the effect of climate is shown in the depth of weathering. Weathering is more rapid in soils that remain moist than in those that dry out or in those that remain saturated most of the year. Fine-textured soils warm up more slowly in spring than coarse-textured soils because they contain more moisture. Soils on south-facing and west-facing slopes receive more sunlight and tend to be drier and warmer than soils on north- and east-facing slopes. The interaction of all these factors affects the development of soils. More information about the climate of Wright County is given in the section "General Nature of the County."

Plant and animal life

Plants and animals are active in the soil-forming processes. They help to decompose plant residues and also affect the chemistry of the soil and hasten soil development. The kinds of plants and animals that live on and in the soils also help to convert plant nutrients to a form that is more readily available to higher plants.

Most of Wright County is in the Minnesota Big Woods area. At the time the county was settled, much of it was covered by deciduous forest. A few areas where tall prairie grasses flourished were in the forest tract. On outwash plains near Monticello and Clearwater, where the soils were too droughty for favorable growth of trees, were large prairie areas. A map showing the original locations of various kinds of vegetation in the county is in the section "Woodland."

The two types of vegetation, forest and prairie, have strongly influenced the formation of soils in this county. Also, some of the county has been covered part of the time by prairie and part of the time by forest. The prairie vegetation encroached on the forests, or forest vegetation came into the prairie as the climate changed, or possibly as the result of fire.

In soils that formed under similar conditions of relief, drainage, parent material, and time, the surface layer of soils that formed under prairie is thicker and darker than that in soils formed under forest. Also, in forest soils, movement of clay and organic material into the subsoil is greater, and the subsoil commonly is less permeable. Large areas of forest soils, such as the Hayden, are in the eastern part of the county. Soils formed under prairie, such as the Wadena, are chiefly on outwash plains and terraces.

The surface layer of the soils formed under prairie and forest is intermediate in thickness between that of the soils formed under prairie or forest, because of the influence of grass. The subsurface, however, generally is like the gray, podzolized horizon typical of forest soils.

This horizon varies in distinctness and in places in undisturbed sandy soils is lacking. The subsoil shows a marked increase in clay and a large accumulation of organic matter. Soils that formed under prairie and forest occur throughout the county but are chiefly in the southwestern part. Lester soils are typical of such soils.

Relief

Relief is an important factor in the formation of soils because of its effect upon drainage, aeration, and erosion. The soils in this county are on nearly level plains to hilly moraines that include many depressions. Soil development, therefore varies greatly. Maximum development takes place in well-drained, gently sloping soils. Little or no development takes place in depressions or in nearly level areas where there is a permanent high water table. Profile development is also slow on steep slopes where runoff is rapid and infiltration of water is slow. In such areas geologic erosion removes the soil material almost as fast as it is formed. The direction of slope also is important. Soil material on steep, north-facing slopes, for example, is darker and deeper than on similar south-facing slopes. This is because soils on north-facing slopes are less subject to heat and to drying winds.

Time

Soils may be well developed, poorly developed, or somewhere in between, depending on the length of time that soil-forming factors have been active. For example, the Lester, Hayden, and similar soils on undulating to rolling areas, have well-developed layers, or horizons. The nearly level Estherville and Wadena soils also have well-developed horizons because the soil material remains in place and internal drainage is good. The Glencoe soils, on the other hand, have less pronounced horizons because they are in depressions where soil moisture is retained. The constantly moist condition inhibits soil-forming processes. Soils on very steep slopes have weak or indistinct horizons. Because of the steepness of the slope, soil material in such places does not remain in place long enough for a distinct profile to form.

Soils formed from alluvial material, such as the Comfrey and Becker, show the effect of a short period of time in their development. Frequent floods continually deposit fresh material on the areas, so time has only slightly affected soil development. Similarly, soils formed in colluvium, such as the Terril, are altered continuously by new additions of material. Soils formed in organic material also lack well-developed horizons, because they are in areas so wet that decomposition of the plant remains that make up the material is restricted.

Classification and Morphology of Soils

Soils are placed in narrow classes for the organization and application of knowledge about their behavior within farms, ranches, or counties. They are placed in broad classes for study and comparison of large areas, such as continents.

Two systems of classifying soils are now in general use in the United States. One of these is the 1938 system (*16*), with later revisions. The other, a new system (*13*, *17*), was placed in general use by the Soil Conservation Service in 1965. In this report the newer system is used almost exclusively, but the placement of soils in the older system is also given (see table 9).

Under the current system, all soils are placed in six categories. They are, beginning with the most inclusive, the order, the suborder, the great soil group, the subgroup, the family, and the series. In this system the criteria used as the bases for classification are observable or measurable properties. The properties are so chosen, however, that soils of similar mode of origin are grouped together.

The 1938 system, with later revisions, also consists of six categories. In the highest of these, the soils of the whole country have been placed in three orders. The next two categories, the suborder and the family, have never been fully developed. As a consequence, they have not been used much in the past. More attention has been centered on the lower categories, the great soil group, the soil series, and the soil type. A further subdivision of the soil type, called a soil phase, is defined, along with soil type and soil series, in the section "How This Survey Was Made," in the front of this report.

In table 9 each soil series of Wright County is placed in its family, subgroup, and order of the current classification system and in its great soil group of the older system. Following the table the morphology of the soils of each series is discussed and a description of a typical soil profile is given for each series. The soil series are discussed in alphabetic order, and the major soils are shown in figure 29 along with their drainage, position on the landscape, and kind of vegetation. Unless otherwise stated, the color given in each profile is that of moist soil. All pH determinations given in a profile were made on undried samples with a Hellige-Truog soil reaction tester.

AMES SERIES

The soils in the Ames series are deep and are somewhat poorly drained to poorly drained. These soils are mainly in the northeastern part of the county in nearly level to gently sloping areas that contain many small depressions. They formed under deciduous hardwoods in calcareous, grayish loam to clay loam glacial till of late Wisconsin age. The water table is seasonally fairly high.

Ames soils are closely associated with Dundas and Nessel soils. Their drainage is similar to that of the Dundas soils but poorer than that of the Nessel. They have a thinner A1 horizon, a thicker, lighter gray A2 horizon, and generally a more thoroughly leached solum than the Dundas soils.

Representative profile of Ames silt loam in a wooded pasture on a slope of 1 percent (SE¼SW¼ sec. 28, T. 120 N., R. 24 W.):

A0—½ inch to 0 of leaves, litter, and duff.
A1—0 to 2 inches, black (10YR 2/1) and dark-gray (10YR 4/1) silt loam; weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.
A21—2 to 6 inches, gray (10YR 5/1) silt loam; weak to moderate, very thin, platy structure; friable; medium acid; abrupt, smooth boundary.
A22—6 to 10 inches, grayish-brown (2.5Y 5/2) silt loam; a few, fine, faint mottles of very dark brown (10YR 2/2); weak to moderate, thick, platy structure; friable; medium acid; clear, wavy boundary.
A & B—10 to 13 inches, very dark grayish-brown (2.5Y 3/2) clay loam; a few, fine, faint mottles of olive brown (2.5Y 4/4); weak, coarse, subangular blocky structure; firm; strongly acid; clear, wavy boundary.

TABLE 9.—*Soil series classified according to the current system of classification and the 1938 system, with its later revisions*

Series	Current classification [1]			1938 classification
	Family	Subgroup	Order	Great soil group
Ames	Fine, montmorillonitic, mesic	Typic Albaqualfs	Alfisols	Planosols.
Anoka	Coarse-loamy, mixed, mesic	Arenic Normudalfs	Alfisols	Gray-Brown Podzolic soils.
Becker	Fine-loamy, mixed, mesic	Cumulic Hapludolls	Mollisols	Alluvial soils intergrading to Brunizems.
Biscay	Fine-loamy over sandy-skeletal, mixed, noncalcareous, mesic.	Typic Haplaquolls	Mollisols	Humic Gley soils.
Biscay, sandy subsoil variant.	Sandy-skeletal, mixed, noncalcareous, mesic.	Typic Haplaquolls	Mollisols	Humic Gley soils.
Blue Earth	Fine-silty, mixed, calcareous, mesic.	Cumulic Haplaquolls	Mollisols	Humic Gley soils.
Braham	Sandy over fine-loamy, mixed, mesic.	Arenic Eutrochrepts	Inceptisols	Regosols intergrading to Gray-Brown Podzolic soils.
Burnsville	Coarse-loamy over sandy-skeletal, mixed, mesic.	Typic Normudalfs	Alfisols	Gray-Brown Podzolic soils.
Canisteo	Fine-loamy, mixed, calcareous, mesic.	Typic Haplaquolls	Mollisols	Humic Gley soils.
Chelsea	Sandy, siliceous, nonacid, mesic	Alfic Normipsamments	Entisols	Regosols.
Comfrey	Fine-loamy, mixed, calcareous, mesic.	Cumulic Haplaquolls	Mollisols	Alluvial soils.
Cordova	Fine-loamy, mixed, noncalcareous, mesic.	Typic Argiaquolls	Mollisols	Humic Gley soils.
Duelm	Coarse-loamy, siliceous, nonacid, mesic.	Aquic Hapludolls	Mollisols	Brunizems.
Dundas	Fine, montmorillonitic, mesic	Mollic Albaqualfs	Alfisols	Planosols intergrading to Gray-Brown Podzolic soils and to Brunizems.
Emmert	Fragmental, siliceous, nonacid, frigid.	Typic Udipsamments	Entisols	Regosols.
Estherville	Coarse-loamy over sandy-skeletal, mixed, mesic.	Typic Hapludolls	Mollisols	Brunizems.
Fairhaven	Fine-loamy over sandy-skeletal, mixed, mesic.	Typic Hapludolls	Mollisols	Brunizems.
Glencoe	Fine-loamy, mixed, noncalcareous, mesic.	Cumulic Haplaquolls	Mollisols	Humic Gley soils.
Guckeen	Fine, montmorillonitic, mesic	Aquic Hapludolls	Mollisols	Brunizems.
Hayden	Fine-loamy, mixed, mesic	Typic Normudalfs	Alfisols	Gray-brown Podzolic soils.
Hubbard	Sandy, siliceous, nonacid, frigid	Entic Haploborolls	Mollisols	Brunizems.
Hubbard, gravelly subsoil variant.	Sandy-skeletal, mixed, nonacid, frigid.	Entic Haploborolls	Mollisols	Brunizems.
Lester	Fine-loamy, mixed, mesic	Mollic Normudalfs	Alfisols	Brunizems intergrading to Gray-Brown Podzolic soils.
Lester, silty variant.	Fine-silty, mixed, mesic	Mollic Normudalfs	Alfisols	Gray-Brown Podzolic soils intergrading to Brunizems.
Le Sueur	Fine-loamy, mixed, mesic	Aquic Argiudolls	Mollisols	Brunizems intergrading to Gray-Brown Podzolic soils.
Marna	Fine, montmorillonitic, noncalcareous, mesic.	Cumulic Haplaquolls	Mollisols	Humic Gley soils.
Milaca	Fine-loamy, mixed, frigid	Typic Fragiudalfs	Alfisols	Gray-Brown Podzolic soils.
Nessel	Fine-loamy, mixed, mesic	Aquic Normudalfs	Alfisols	Gray-Brown Podzolic soils.
Rasset	Coarse-loamy, mixed, mesic	Typic Argiudolls	Mollisols	Brunizems intergrading to Gray-Brown Podzolic soils.
Salida	Sandy-skeletal, mixed, mesic	Entic Hapludolls	Mollisols	Regosols intergrading to Brunizems.
Sattre, silty variant.	Fine-loamy over sandy-skeletal, mixed, mesic.	Mollic Normudalfs	Alfisols	Gray-Brown Podzolic soils intergrading to Brunizems.
Storden	Fine-loamy, mixed, mesic	Entic Hapludolls	Mollisols	Regosols.
Talcot	Fine-loamy over sandy-skeletal, mixed, calcareous, mesic.	Typic Haplaquolls	Mollisols	Humic Gley soils.
Terril	Fine-loamy, mixed, mesic	Cumulic Hapludolls	Mollisols	Brunizems.
Wadena	Fine-loamy over sandy-skeletal, mixed, mesic.	Typic Hapludolls	Mollisols	Brunizems.
Watseka	Sandy, siliceous, nonacid, mesic	Aquic Entic Hapludolls	Mollisols	Brunizems.
Webster	Fine-loamy, mixed, noncalcareous, mesic.	Typic Haplaquolls	Mollisols	Humic Gley soils.
Webster, silty variant.	Fine-silty, mixed, noncalcareous, mesic.	Typic Haplaquolls	Mollisols	Humic Gley soils.

[1] Placement of some soil series in the present system of classification, particularly in families, may change as more precise information becomes available.

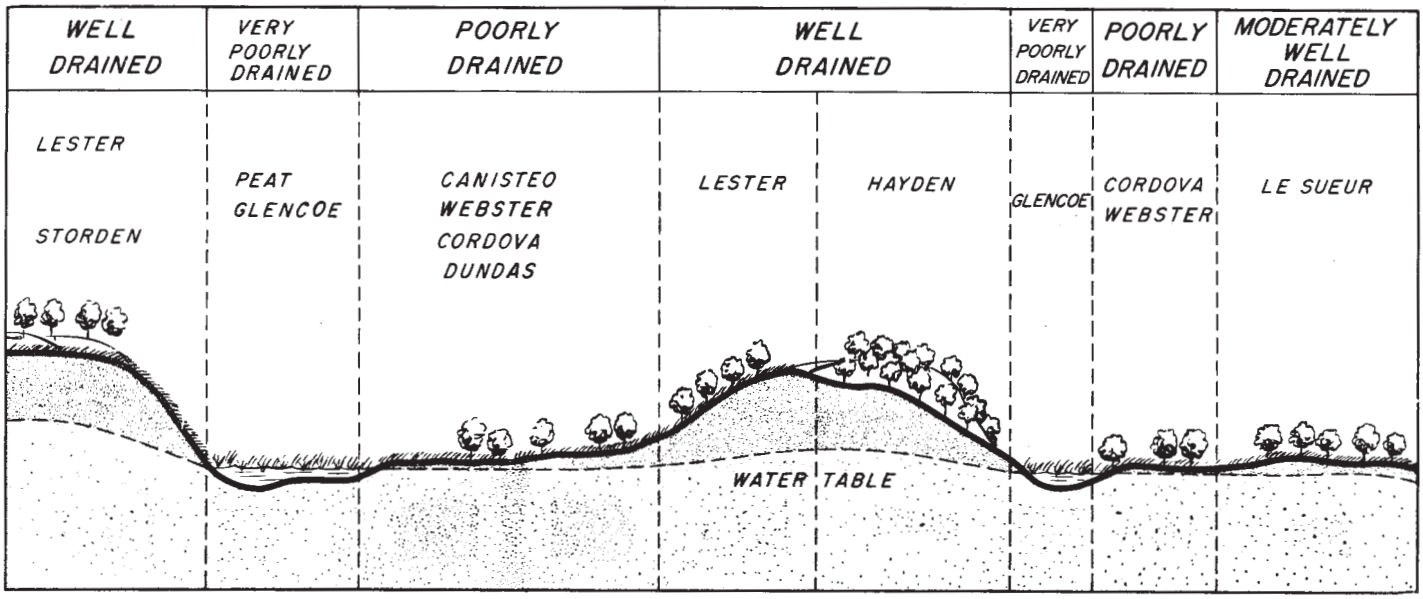

Figure 29.—**Major soil series in Wright County, their drainage, position on the landscape, and kind of vegetation.**

B21—13 to 21 inches, olive-brown (2.5Y 4/4) silty clay; thin, very dark grayish-brown (2.5Y 3/2) organic stains; moderate, medium and coarse, prismatic structure that breaks to moderate, fine, angular blocky; very firm; strongly acid; clear, wavy boundary.

B22g—21 to 28 inches, olive (5Y 5/3) silty clay loam; weak, fine and medium, blocky structure; very firm; thin, discontinuous, very dark grayish-brown (2.5Y 3/2) organic stains; slightly acid; clear, wavy boundary.

C—28 to 36 inches, olive-gray (5Y 5/2) clay loam; a few very dark grayish-brown (2.5Y 3/2) organic stains along root channels; massive; firm; calcareous.

The A1 horizon is less than 3 inches thick and generally is 1 to 2 inches thick. The A2 horizon ranges from 4 to 10 inches in thickness and has platy structure. The B2 horizon ranges from heavy clay loam to clay but generally is silty clay. It contains much more clay than the A and C horizons. Structure of the B2 horizon is moderate to strong, very fine, fine, and medium, blocky to moderate, coarse, prismatic; clay films are patchy to continuous. The A horizon is neutral to medium acid. The B2 horizon is slightly acid to strongly acid but generally is medium acid to strongly acid. Depth to calcareous underlying material ranges from 24 to 40 inches. In places stones and boulders and variable amounts of shale fragments are on the surface and in the soil.

ANOKA SERIES

The Anoka series consists of somewhat excessively drained, nearly level to steep soils. These soils formed under deciduous hardwoods in noncalcareous fine sandy outwash of late Wisconsin age. They characteristically have variable, discontinuous textural layers in the substratum.

Anoka soils formed in material similar to that of the Chelsea soils, which are excessively drained and generally have layers of iron-stained or organic-stained material in the lower substratum. They have drainage similar to that of the Braham soils, but those soils formed in fairly thick deposits of loamy fine sand or fine sand underlain by deep, finer textured material and lack the textural layers typical of the Anoka soils.

Representative profile of Anoka loamy fine sand in a deciduous hardwood forest on a slope of 5 percent (NW¼SE¼ sec. 35, T. 120 N., R. 28 W.):

A1—0 to 2 inches, very dark gray (10YR 3/1) loamy fine sand; single grain; very friable; medium acid; abrupt, smooth boundary.

A21—2 to 6 inches, dark grayish-brown (10YR 4/2) fine sand, light brownish gray (10YR 6/2, dry); single grain; coherent; strongly acid; clear, smooth boundary.

A22—6 to 20 inches, dark grayish-brown (10YR 4/2) fine sand, pale brown (10YR 6/3, dry); single grain; coherent; medium acid; clear, smooth boundary.

B21—20 to 23 inches, dark-brown (10YR 3/3) sandy loam; coats of grayish brown (10YR 5/2); weak, coarse, subangular blocky structure; friable; medium acid; clear, irregular boundary.

B22—23 to 25 inches, dark-brown (10YR 3/3) sandy loam; weak, coarse, subangular blocky structure; friable; medium acid; clear, irregular boundary.

A23—25 to 32 inches, dark-brown (10YR 4/3) and brown (10YR 5/3), weak, loamy fine sand; weak, coarse, subangular blocky structure; very friable; medium acid; clear, irregular boundary.

B23—32 to 34 inches, dark-brown (10YR 3/3) sandy loam that is darker colored than the material in the B21 and B22 horizons; weak, coarse, subangular blocky structure; friable; medium acid; clear, irregular boundary.

A24—34 to 45 inches, dark-brown (10YR 4/3) fine sand; single grain; loose; medium acid; clear, irregular boundary.

B24—45 to 46 inches, dark yellowish-brown (10YR 4/4) sandy loam; massive; friable; medium acid.

The A horizon ranges from loamy fine sand to fine sand. In undisturbed areas the A1 horizon is less than 3 inches thick. The A21 and A22 horizons are indistinct to distinct and are characterized by bleached grains of sand. The underlying material consists of variable discontinuous layers of fine sand, loamy fine sand, sandy loam, and light loam, and layers of fine sand and loamy fine sand are predominant. These layers are mainly of geologic origin, but downward movement of organic matter, iron, and in places clay, has caused coloration

and a slight increase of clay in some layers and leaching in others. The soils are slightly acid to strongly acid to a depth of more than 60 inches, but they are medium acid in most places.

BECKER SERIES

The Becker series consists of moderately deep, nearly level, moderately well drained soils on fairly high bottoms of the Mississippi River. These soils formed in sandy and gravelly alluvium deposited by rivers and other streams. The native vegetation was grass and various kinds of hardwoods.

Becker soils are subject to occasional flooding when the streams overflow, but the water drains away rapidly when the streams subside. Except immediately after floods and in wet weather, the water table is generally at a depth of 6 feet or more.

Becker soils are better drained than the Comfrey soils, which formed in deep, calcareous silty alluvium. They have a coarser textured substratum than the Terril soils. Their surface layer is thicker than that of the Wadena soils, which are better drained and are not subject to flooding.

Representative profile of Becker loam in a cultivated field on a slope of less than 1 percent in an old meander channel between terraces in outwash of the Mississippi River (NE¼SE¼ sec. 15, T. 121 N., R. 23 W.):

Ap—0 to 12 inches, black (10YR 2/1) loam; weak, very coarse, subangular blocky structure; friable; medium acid; gradual, smooth boundary.

A12—12 to 20 inches, very dark brown (10YR 2/2) to very dark grayish-brown (10YR 3/2) loam; weak, very coarse, subangular blocky structure; friable; medium acid; gradual, smooth boundary.

A13—20 to 24 inches, very dark grayish-brown (10YR 3/2) loam; weak, medium to coarse, subangular blocky structure; friable; medium acid; gradual, smooth boundary.

IIB21—24 to 28 inches, dark-brown (10YR 4/3) light sandy loam with very thin, discontinuous infiltrations of dark brown (10YR 3/3); very weak, coarse, subangular blocky structure; friable; medium acid; gradual, smooth boundary.

IIB22—28 to 35 inches, dark yellowish-brown (10YR 4/4) light sandy loam; weak, medium and coarse, subangular blocky structure; friable; medium acid; gradual, smooth boundary.

IIIC—35 to 50 inches, brown (10YR 5/3), dark yellowish-brown (10YR 4/4), pale-brown (10YR 6/3), and very pale brown (10YR 7/3) sand; single grain; loose; medium acid.

The surface layer generally is loam, but small areas of fine sandy loam are included. This layer varies considerably in thickness, though it generally is 20 to 30 inches thick. Below is grayish-brown loam or sandy loam that in places has faint light olive-brown mottles. Depth to the sandy and gravelly substratum generally is 24 to 36 inches but is as much as 48 inches in places. In most places the substratum is sand, but in some areas it contains a fairly large amount of gravel. Becker soils are neutral to medium acid in the surface layer but are calcareous within a depth of 36 to 72 inches.

BISCAY SERIES

The Biscay series consists of moderately deep, nearly level, poorly drained soils. These soils formed under grass over grayish, calcareous sand and gravel of late Wisconsin age. They are on flats and in drainageways on outwash plains and stream terraces. The water table is seasonally high.

Biscay soils are closely associated with the well-drained Wadena soils. They are not so poorly drained as the Talcot soils and have a thinner A horizon and less intensively gleyed underlying material.

Representative profile of Biscay loam in a cultivated field on a slope of 1 percent (SW¼SW¼ sec. 34, T. 119 N., R. 28 W.):

A1p—0 to 9 inches, black (10YR 2/1) loam; weak, very fine, subangular blocky structure; friable; slightly calcareous; abrupt, smooth boundary.

A1—9 to 14 inches, black (10YR 2/1) loam; weak, very fine, subangular blocky structure; friable; slightly calcareous; clear, smooth boundary.

Bg1—14 to 22 inches, dark grayish-brown (2.5Y 4/2) loam; common, fine, distinct mottles of olive gray (5Y 4/2) and olive (5Y 4/3); weak, very fine, subangular blocky structure; friable; slightly calcareous; clear, smooth boundary.

Bg2—22 to 32 inches, grayish-brown (2.5Y 5/2) loam; common, fine, distinct mottles of olive (5Y 5/3); massive; friable; slightly calcareous; clear, smooth boundary.

Bg3—32 to 36 inches, olive (5Y 5/3) loam that grades to sandy loam; many, fine, distinct mottles of olive gray (5Y 5/2); massive; friable; calcareous; clear, smooth boundary.

C—36 to 48 inches, variegated olive-gray (5Y 5/2), olive (5Y 5/3), light olive-gray (5Y 6/), and pale-olive (5Y 6/3) fine gravel and coarse sand; single grain; loose; calcareous.

The A horizon ranges from 10 to 16 inches in thickness. In texture the Bg horizon ranges from loam to sandy clay loam and clay loam. The substratum is predominantly stratified gravel and coarse sand. Depth to the coarse underlying material is 24 to 40 inches. The A horizon is neutral to very mildly alkaline, and the Bg horizon and underlying material are neutral to moderately alkaline.

The reaction of the A horizon is neutral to very mildly alkaline, which may be out of the range of the concept for the Biscay series as it is generally known in Minnesota.

BISCAY SERIES, SANDY SUBSOIL VARIANT

The variants from the normal Biscay soils are shallow and poorly drained to somewhat poorly drained. These soils are nearly level and are on flats and in slightly depressed drainageways on outwash plains and stream terraces. They formed under grass over grayish, outwash sand and gravel. The water table is fairly high.

These variants are closely associated with the somewhat excessively drained Estherville soils. They are coarser textured than the normal Biscay soils and are less deep to sand and gravel.

Representative profile of Biscay loam, sandy subsoil variant, in a cultivated drainageway on a slope of 1 percent (SE¼SE¼ sec. 31, T. 122 N., R. 25 W.):

Ap—0 to 8 inches, black (10YR 2/1 to N 2/0) loam; weak, very fine, subangular blocky structure; very friable; neutral; clear, smooth boundary.

A3—8 to 11 inches, very dark gray (10YR 3/1) sandy loam; weak, very fine, subangular blocky structure; very friable; slightly acid; gradual, smooth boundary.

B—11 to 15 inches, very dark gray (10YR 3/1) and very dark grayish-brown (10YR 3/2) loamy sand; weak, very fine, subangular blocky structure; loose; slightly acid; clear, smooth boundary.

C1—15 to 24 inches, dark grayish-brown (2.5Y 4/2) coarse sand and fine gravel; common, fine, faint mottles of light olive brown (2.5Y 5/4) and olive brown (2.5Y 4/4); single grain; loose; slightly acid; clear, smooth boundary.

C2—24 to 38 inches, variegated olive-gray (5Y 5/2), olive (5Y 5/3), grayish-brown (2.5Y 5/2), and light olive-brown (2.5Y 5/4) coarse sand; single grain; loose; slightly acid; clear, smooth boundary.

C3—38 to 55 inches, variegated olive-gray (5Y 5/2) and olive (5Y 5/3 and 5/4) fine gravel and coarse sand; single grain; loose; slightly acid.

The surface layer generally is loam, but in a few areas it is sandy loam. Drainage is generally poor, but in places the soil is somewhat poorly drained, and here the color is more brownish and the mottles of olive less intensive. Depth to underlying sand and gravel is between 12 and 24 inches. The solum is neutral to slightly acid. The substratum is coarse textured and generally is calcareous within a depth of 48 to 72 inches.

BLUE EARTH SERIES

Soils of the Blue Earth series are deep, very poorly drained, and silty. They are in the shallow basins of former lakes and ponds, where the water table is high. The native vegetation was slough grasses, sedges, reeds, and willows.

Blue Earth soils have drainage similar to that of the Glencoe and Talcot soils. They have a grayer, fluffier, and more calcareous surface layer than the Glencoe soils and are less deep to sand and gravel than the Talcot soils.

Representative profile of Blue Earth silt loam in a depression under reed canarygrass on a slope of less than 1 percent (SW¼SW¼ sec. 23, T. 119 N., R. 26 W.):

A1—0 to 6 inches, black (10YR 2/1) silt loam; moderate, medium, granular structure; very friable; slightly plastic when wet; matted roots; a few small snail shells; strongly calcareous; clear, smooth boundary.

A12—6 to 20 inches, black (10YR 2/1) silt loam; moderate, medium, granular structure; very friable when moist, slightly plastic when wet; a large number of fine snail shells; strongly calcareous; clear, wavy boundary.

A3—20 to 23 inches, black (10YR 2/1) silty clay loam; moderate, fine, granular structure; firm to friable when moist; slightly plastic when wet; many fine snail shells, but the number is less than in the A12 layer; calcareous; clear, wavy boundary.

C1—23 to 26 inches, black (10YR 2/1) silty clay loam; weak, very fine, subangular blocky structure; firm when moist, plastic when wet; a few fine snail shells; slightly calcareous; clear, wavy boundary.

C2—26 to 45 inches, black (2.5Y 2/1) silty clay loam; massive; firm when moist, plastic when wet; no snail shells; slightly calcareous.

The surface layer generally is silt loam, but in a few places it is silty clay loam. A layer of calcareous peat or muck that contains many snail shells and is as much as 12 inches thick generally is on the surface. In cultivated areas the surface layer generally is fluffy when dry. The A horizon is black to very dark gray silt loam that is 18 to 36 inches thick and is mildly alkaline to strongly alkaline. Below is black to light olive-gray material that ranges from silt loam to clay loam but generally is silty clay loam. This underlying material is mildly alkaline to moderately alkaline. The subsoil is only slightly mottled. Soluble alkali salts, largely sulfates, are at the surface in many places, and gypsum crystals are in the subsoil in some places.

BRAHAM SERIES

Soils of the Braham series are somewhat excessively drained and are nearly level to steep. They are in the northern part of the county. They formed under deciduous hardwoods in sandy material underlain by medium textured to moderately fine textured material of late Wisconsin Age.

Braham soils have drainage similar to that of the Anoka soils, but the substratum of those soils is more variable in texture. They are not so excessively drained as the Chelsea soils, which formed in deep, acid fine sand and lack layers of finer textured material within a depth of 60 inches.

Representative profile of Braham loamy fine sand on a slope of 4 percent in a woods consisting of popple, red ash, white oak, and ironwood (SE¼SE¼ sec. 22, T. 119 N., R. 25 W.):

A1—0 to 3 inches, very dark grayish-brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2, dry) and dark gray (10YR 4/1, dry) with gray (10YR 5/1, dry) bleached sand grains; weak, very fine, granular structure; loose; slightly acid; clear, wavy boundary.

A21—3 to 16 inches, dark grayish-brown (10YR 4/2, dry) fine sand; slightly coherent lumps break to single grains under slight pressure; medium acid; clear, wavy boundary.

A22—16 to 24 inches, dark-brown (10YR 4/3) and brown (10YR 5/3) fine sand; slightly coherent lumps break to single grains under very slight pressure; medium acid; clear, wavy boundary.

A23—24 to 36 inches, brown (10YR 5/3) fine sand; single grain; loose; medium acid; abrupt, wavy boundary.

IIB1—36 to 40 inches, dark-brown (10YR 4/3) sandy loam that grades to loam; weak, fine, subangular blocky structure; friable; lighter colored, weathered material coats faces of peds; medium acid; clear, wavy boundary.

IIB2—40 to 52 inches, dark-brown (10YR 4/3) and dark yellowish-brown (10YR 4/4) clay loam, grayish brown (10YR 5/2, dry); gray (10YR 5/1) silica coatings; weak, medium to coarse, subangular blocky structure; thin, discontinuous clay films; firm when moist, slightly plastic and slightly sticky when wet; very dark grayish-brown (10YR 3/2) organic stains; a few fine shale fragments; medium acid; clear, smooth boundary.

IIC1—52 to 55 inches, light olive-brown (2.5Y 5/4) and olive-brown (2.5Y 4/4) clay loam; massive; friable to firm when moist, slightly plastic and slightly sticky when wet; medium acid; clear, smooth boundary.

IIC2—55 to 73 inches, light olive-brown (2.5Y 5/4) clay loam; massive; friable when moist, slightly plastic and slightly sticky when wet; neutral; clear, smooth boundary.

IIC3—73 to 80 inches, light olive-brown (2.5Y 5/4) clay loam; massive; friable when moist, slightly plastic and slightly sticky when wet; slight to strong effervescence with hydrochloric acid.

The A1 horizon in undisturbed areas is very dark gray (10YR 3/1), very dark grayish-brown (10YR 3/2), or very dark brown (10YR 2/2) loamy fine sand or fine sand less than 3 inches thick. It is dark gray (10YR 4/1) to dark grayish brown (10YR 4/2) when dry. In places an indistinct to distinct A2 horizon, characterized by bleached grains of sand, is present. In cultivated areas the plow layer generally is dark grayish-brown (10YR 3/2) loamy fine sand or fine sand. The underlying material, to a depth of 20 to 42 inches, and generally within a depth of 24 to 36 inches, is dark grayish-brown (10YR 4/2) to dark yellowish-brown (10YR 4/4)

loamy fine sand or fine sand. In places irregular, discontinuous, very thin organic layers and stains occur. Below a depth of 20 to 42 inches, but generally within a depth of 24 to 36 inches, are layers that range in texture from medium sandy loam to clay loam or silty clay loam. These layers rest on calcareous, medium textured to moderately fine textured parent material. The solum ranges from neutral to medium acid and generally is slightly acid to medium acid. Depth to free lime carbonates ranges from 40 to 60 inches.

BURNSVILLE SERIES

The Burnsville soils are shallow and are somewhat excessively drained. These soils formed in grayish, calcareous, sandy and gravelly glacial till of late Wisconsin age. They are on undulating to very steep and irregular slopes of moraines, mainly in the northwestern part of the county. The native vegetation was a deciduous hardwood forest consisting mainly of aspen and oak but that also included a few elm, ash, and basswood trees.

Burnsville soils are closely associated with the well-drained, deep Hayden soils but are coarser textured than those soils. In drainage they are similar to the Estherville soils, but they have a thinner, somewhat lighter colored A1 horizon and have an A2 horizon that is lacking in Estherville soils. Also their B2 horizon, unlike that of the Estherville soils, has a marked increase in clay content.

Representative profile of Burnsville loam in a wooded area on a slope of 10 percent; the vegetation is maple, elm, basswood, and sumac; large stones and boulders are in the profile and on the surface (SE¼NW¼ sec. 5, T. 120 N., R. 28 W.):

A0—½ inch to 0 of leaves, litter, and duff.
A1—0 to 3 inches, very dark brown (10YR 2/2) loam, very dark gray (10YR 3/1, dry); weak to moderate granular structure; friable when moist, slightly plastic and slightly sticky when wet; medium acid; clear, wavy boundary.
A2—3 to 5 inches, very dark grayish-brown (10YR 3/2) loam, dark gray (10YR 4/1, dry); weak, very thin, platy structure to weak, very fine, granular; friable when moist, slightly plastic and sticky when wet; medium acid; clear, wavy boundary.
B21—5 to 10 inches, very dark grayish-brown (10YR 3/2) light clay loam; weak to moderate, very fine and fine, subangular blocky structure; dark-gray (10YR 4/1, dry) coatings; friable when moist, slightly plastic and slightly sticky when wet; medium acid; clear, wavy boundary.
B22—10 to 15 inches, dark grayish-brown (10YR 4/2) and dark-brown (10YR 4/3) clay loam; weak to moderate, very fine and fine, subangular blocky structure; dark-gray (10YR 4/1) coatings; friable when moist, slightly plastic and slightly sticky when wet; medium acid; clear, wavy boundary.
B3—15 to 19 inches, dark-brown (7.5Y 4/4, 10YR 4/3 and 3/3) gravelly loamy sand; single grain; loose; strongly acid; clear, wavy boundary.
C1—19 to 34 inches, dark-brown (7.5Y 4/4) gravel and coarse sand and cobbly and stony material; single grain; loose; medium acid.
C2—34 to 39 inches, dark-brown (7.5Y 4/4, 10YR 4/3 and 3/3) gravel and coarse sand and stony and cobbly material and many lime pebbles; single grain; loose; slightly calcareous.
C3—39 to 45 inches, variegated brown (10YR 5/3), yellowish-brown (10YR 5/4), and dark yellowish-brown (10YR 4/4) coarse sand and gravel and stony and cobbly material; single grain; loose; many reddish and orange iron stains; calcareous.

Sandy loam or loam make up the surface layer. The A1 horizon ranges from 1 to 3 inches in thickness. The A2 horizon is 1 to 4 inches thick and in structure ranges from weak, very thin, platy to weak, very fine, granular. The B2 horizon ranges from heavy sandy loam to clay loam. Its structure is weak to moderate, very fine, and fine blocky. Silica coatings are on the peds. Clay films are very thin and patchy or are absent.

The A horizon ranges from slightly acid to medium acid, and the B horizon from slightly acid to strongly acid. The upper part of the underlying material is slightly acid to medium acid, but calcareous sand and gravel are within a depth of 40 inches. Large stones and boulders generally are on the surface and in the soil.

CANISTEO SERIES

The soils in the Canisteo series are deep, poorly drained, and calcareous. These soils are on level and slightly elevated, irregular areas around depressions. They formed in friable, calcareous glacial till of late Wisconsin age. The native vegetation was prairie grasses and sedges.

Canisteo soils are closely associated with Webster soils and have similar drainage, but unlike those soils, they are calcareous throughout the solum. They are also closely associated with the very poorly drained Glencoe soils, which are in most of the depressions. Canisteo soils are finer textured throughout the solum than the poorly drained Biscay soils, which are moderately deep to gravel and sand.

Representative profile of Canisteo silty clay loam in a bluegrass pasture on a slope of 1 to 2 percent; the area is irregular and slightly elevated and is around a depression in a Glencoe soil (SE¼SW¼ sec. 10, T. 118 N., R. 26 W.):

A1—0 to 11 inches, black (N 2/0) silty clay loam; moderate, very fine, subangular blocky structure; friable when moist, slightly plastic when wet; a few fine fragments or snail shells; calcareous; clear, smooth boundary.
A3—11 to 15 inches, black (10YR 2/1) silty clay loam; weak, very fine, subangular blocky structure to massive; firm when moist, plastic when wet; a few fine fragments or snail shells; calcareous; clear, wavy boundary.
ACg1—15 to 24 inches, very dark gray (5Y 3/1) silty clay loam; massive; firm when moist, plastic when wet; calcareous; clear, wavy boundary.
ACg2—24 to 27 inches, black (5Y 2/1) and gray (5Y 5/1) clay loam or heavy silty clay loam; common, fine, faint mottles of olive (5Y 5/3); massive; firm when moist, plastic when wet; calcareous; clear, wavy boundary.
Cg1—27 to 30 inches, olive-gray (5Y 5/2) clay loam; many, fine, prominent mottles of olive (5Y 5/3, 5/4, and 5/6); massive; firm when moist, slightly plastic when wet; a few lime pebbles; calcareous; clear, wavy boundary.
Cg2—30 to 34 inches, olive-gray (5Y 5/2) clay loam; many, fine, prominent mottles of pale olive (5Y 6/3 and 6/4); massive; firm when moist, slightly plastic when wet; pronounced reddish and orange iron stains; calcareous; clear, wavy boundary.
Cg3—34 to 41 inches, olive-gray (5Y 5/2) silty clay loam or clay loam; common, fine, distinct mottles of olive (5Y 5/4); massive; firm and friable when moist,

slightly plastic and sticky when wet; a few reddish and orange iron stains; calcareous; clear, wavy boundary.

Cg4—41 to 48 inches, olive-gray (5Y 5/2) sandy clay loam; common, fine, distinct mottles of olive (5Y 5/4); massive; friable when moist, slightly plastic and slightly sticky when wet; pronounced reddish and orange iron stains; calcareous.

The A horizon is silty clay loam in most places, but in small included areas it is silt loam and clay loam. It is black to very dark gray in color. In thickness the A horizon ranges from 12 to 24 inches, but it generally is 12 to 18 inches thick. In some places the surface soil has a distinct light grayish color when dry. The AC and C horizons are clay loam or silty clay loam and have little increase in clay. They have very weak to no structural development, but they are mostly olive gray in color, and the degree of mottling varies. Canisteo soils are calcareous throughout the solum. A few fine fragments of shells generally are in the surface soil, though these are not always present. In places stones also are in the surface soil.

CHELSEA SERIES

The Chelsea series consists of very deep, excessively drained soils. These soils formed in loose, noncalcareous fine sand of late Wisconsin age. The native vegetation was deciduous hardwoods, mostly oak, aspen, and hazel.

Chelsea soils formed in material similar to that of the somewhat excessively drained Anoka soils but lack the textural layers in the lower substratum that are typical of those soils. Drainage is more excessive than that of the Braham soils, which consist of loamy fine sand or fine sand underlain by deep, medium textured to moderately fine textured material. Chelsea soils have drainage similar to that of the Hubbard soils, but they have a thinner and somewhat lighter and finer textured A1 horizon. Also Chelsea soils have an A2 horizon, and Hubbard soils lack this horizon.

Representative profile of Chelsea fine sand on a slope of 5 percent under red oak, hazelbrush, and juneberry in an upland area near the transition to outwash plains of the Mississippi River (SE¼SE¼ sec. 36, T. 122 N., R. 26 W.):

A1—0 to 3 inches, very dark gray (10YR 3/1) to dark-gray (10YR 4/1) fine sand, dark gray (10YR 4/1, dry) to gray (10YR 5/1, dry); weak, fine and very fine, granular structure; loose; thick, matted roots; strongly acid; clear, wavy boundary.

A2—3 to 4 inches, dark grayish-brown (10YR 4/2) fine sand, grayish brown (10YR 5/2, dry) to light brownish gray (10YR 6/2, dry); single grain; bleached sand grains; loose; strongly acid; gradual, wavy boundary.

C1—4 to 10 inches, dark-brown (10YR 4/3) fine sand, brown (10YR 5/3, dry); single grain; very weakly coherent lumps that break under very slight pressure; strongly acid; gradual, wavy boundary.

C2—10 to 22 inches, yellowish-brown (10YR 5/4) fine sand; single grain; coherent lumps that break under slight pressure; a few small pebbles; strongly acid; gradual, wavy bundary.

C3—22 to 31 inches, brown (10YR 5/3) and yellowish-brown (10YR 5/4) fine sand, pale brown (10YR 6/3, dry) and light yellowish brown (10YR 6/4, dry); single grain; very weakly coherent lumps that break under very slight pressure; medium acid; gradual, wavy boundary.

C4—31 to 55 inches, brown (10YR 5/3) and yellowish-brown (10YR 5/4) fine sand; pale brown (10YR 6/3, dry) and brown (10YR 5/3, dry); single grain; loose; coherent, discontinuous, tilted layers of dark yellowish-brown and dark-brown (10YR 3/4 and 4/3) very weak loamy sand; layers ⅛ to ½ inch thick and about 6 inches apart; medium acid.

The surface layer is fine sand in most places, but in small included areas it is loamy fine sand. The A1 horizon is less than 3 inches thick and generally is only 1 to 2 inches thick. The A2 horizon is less than 2 inches thick and characteristically contains bleached grains of sand. The C horizon is fine sand throughout and has no structural development. Discontinuous, tilted layers stained with iron and organic matter generally are at a depth below 30 inches. These layers range from fine sand to weak loamy fine sand and are ⅛ to ½ inch thick. They generally are about 6 inches apart. The reaction is medium acid to strongly acid to a depth of more than 72 inches.

COMFREY SERIES

The Comfrey series consists of deep, poorly drained soils formed in medium textured to moderately fine textured, calcareous alluvium. These soils are on bottom lands of the Mississippi and Crow Rivers and of smaller streams in the county. They are subject to variable flooding. Wetland grasses, sedges, and willows made up the native vegetation.

Comfrey soils are similar to the Webster soils in drainage, but they have a thicker surface layer and formed in alluvium rather than glacial till.

In this county two soil types are recognized. Comfrey silty clay loam is closely associated with Comfrey silty clay loam, depressional, which is in the lower channels in the bottom lands, is very poorly drained, and has a thicker, generally more calcareous A horizon. It also is more intensively gleyed.

Representative profile of Comfrey silty clay loam on a slope of 1 percent in a meadow on the bottom land of the North Fork of the Crow River, which is flooded frequently (SW¼NW¼ sec. 13, T. 119 N., R. 26 W.):

A1—0 to 12 inches, black (10YR 2/1) silty clay loam; moderate, very fine, subangular blocky structure; firm when moist, plastic and slightly sticky when wet; neutral; clear, smooth boundary.

A3—12 to 17 inches, black (10YR 2/1) silty clay loam; weak, very fine, subangular blocky structure; firm when moist, plastic and sticky when wet; slightly acid; gradual, wavy boundary.

Cg1—17 to 23 inches, very dark gray (5Y 3/1) and black (5Y 2/1) silty clay loam; common, fine, distinct mottles of dark olive gray (5Y 3/2) and olive gray (5Y 4/2); massive; firm when moist, plastic and sticky when wet; slightly acid; gradual, wavy boundary.

Cg2—23 to 29 inches, very dark gray (5Y 3/1) and black (5Y 2/1) silty clay loam; many, fine, distinct mottles of olive gray (5Y 4/2) and olive (5Y 4/3); massive; firm when moist, plastic and sticky when wet; calcareous; gradual, wavy boundary.

Cg3—29 to 34 inches, olive-gray (5Y 5/2) and olive (5Y 5/3) silty clay loam; massive; many, fine, distinct mottles of dark gray (5Y 4/1) and very dark gray (5Y 3/1); massive; firm when moist, plastic and sticky when wet; calcareous; gradual, wavy boundary.

Cg4—34 to 42 inches, olive-gray (5Y 5/2) and olive (5Y 5/3) silty clay loam; common, fine, distinct mottles of olive (5Y 5/4); massive; firm when moist, plastic and sticky when wet; calcareous.

The A horizon generally is silty clay loam, but in small included areas it is silt loam. It ranges from 16 to 30 inches in thickness. The underlying material ranges from silt loam to clay loam but generally is silty clay loam. Comfrey soils range from slightly acid to mildly alkaline and generally are mildly alkaline within a depth of 48 inches. They are susceptible to flooding, and most areas therefore cannot be cropped.

CORDOVA SERIES

Soils of the Cordova series are deep and are poorly drained. They are on broad, level areas and in slightly depressed drainageways, mainly on ground moraines in the county. These soils formed in friable, calcareous, grayish loam or clay loam glacial till of late Wisconsin age. Originally the vegetation was grasses, but deciduous hardwood trees later encroached on the areas.

Cordova soils have drainage similar to that of the Webster soils and are closely associated with them, but they have a B2 horizon that is finer textured, has stronger structure, and is more acid. Unlike the Webster soils, they also generally have an indistinct A2 horizon. Cordova soils have a somewhat thicker, finer textured A1 horizon than the somewhat poorly drained to poorly drained Dundas soils. Also, in contrast to those soils, they have an indistinct A2 horizon and are less deeply leached. They have drainage resembling that of the Marna soils but have a thinner A1 horizon that contains less clay than the corresponding layer in the Marna soils, and their B horizon contains more clay and is more acid.

Representative profile of Cordova silty clay loam on a slope of 1 percent in a wooded pasture under vegetation of oak, elm, and bluegrass (SW¼SE¼ sec. 34, T. 118 N., R. 26 W.):

A1—0 to 8 inches, black (10YR 2/1) silty clay loam; moderate to strong, very fine, subangular blocky structure; friable to firm when moist, slightly plastic and slightly sticky when wet; neutral; clear, smooth boundary.

AB—8 to 10 inches, very dark gray (10YR 3/1) to black (10YR 2/1) silty clay loam; moderate to strong, very fine, subangular blocky structure; patches of clay film on vertical faces of peds; firm when moist, plastic and sticky when wet; neutral; clear, smooth boundary.

B21g—10 to 16 inches, very dark gray (5Y 3/1) silty clay; a few, fine, faint mottles of olive gray (5Y 4/2) and dark olive gray (5Y 3/2); strong, very fine, angular blocky structure; continuous, distinct clay films on all ped faces; very firm when moist, plastic and sticky when wet; strongly acid; clear, smooth boundary.

B22g—16 to 28 inches, olive-gray (5Y 4/2) and olive (5Y 5/3) silty clay; many, very dark brown (10YR 2/2) and black (10YR 2/1) organic stains; weak, medium, prismatic structure that breaks to strong, medium, subangular blocky; continuous, distinct clay films on all ped faces; very firm when moist, plastic and sticky when wet; slightly acid; abrupt, smooth boundary.

Cg—28 to 48 inches, olive-gray (5Y 5/2) and olive (5Y 5/3) loam or light clay loam; common, fine, distinct mottles of olive (5Y 5/4 to 5/6); black (10YR 2/1) and very dark brown (10YR 2/2) organic stains; massive; friable when moist, slightly plastic and slightly sticky when wet; many orange and reddish iron stains; a few lime pebbles; calcareous.

The A1 horizon is generally silty clay loam, but in small included areas it is silt loam. In thickness the A1 horizon ranges from 8 to 14 inches, but in most places it is 8 to 10 inches thick. Cordova soils have an indistinct A2 horizon, or this layer is lacking in places. If present, the A2 horizon is dark gray and is less than 3 inches thick and lacks platy structure. The B2 horizon is more clayey than the A and C horizons. Its texture ranges from heavy silty clay loam and clay loam to silty clay or clay, but it generally is silty clay. In structure the B2 horizon ranges from moderate to strong, very fine and fine, blocky to prismatic. The peds are well developed and have patchy to continuous clay films on their faces. Thickness of the solum ranges from 24 to 36 inches, but the average depth to free lime carbonates generally is 28 to 30 inches. The A horizon is neutral to slightly acid, and the B2 horizon is slightly acid to strongly acid. In places a few stones and boulders are on the surface and in the soil and there are varying amounts of shale fragments.

DUELM SERIES

The soils in the Duelm series are moderately deep, moderately coarse textured, and somewhat poorly drained. These soils are in drainageways and slight depressions in outwash plains and terraces. They formed under grass in loose, noncalcareous sand and gravel of late Wisconsin age.

Duelm soils occupy slight depressions within areas of the somewhat excessively drained Hubbard and Estherville soils. Their drainage is similar to that of the Watseka soils, but they are coarser textured throughout the solum.

Representative profile of Duelm sandy loam on a slope of less than 1 percent in a slight depression in a cultivated field (SW¼SE¼ sec. 31, T. 122 N., R. 25 W.):

A1p—0 to 10 inches, black (N 2/0) sandy loam; weak, very fine and fine, granular structure; very friable; slightly acid.

A3—10 to 14 inches, black (10YR 2/1) to very dark gray (10YR 3/1) sandy loam; weak, very fine, granular structure; very friable; medium acid.

B2—14 to 19 inches, very dark grayish-brown (10YR 3/2) sandy loam; single grain; loose; medium acid.

C1—19 to 26 inches, dark grayish-brown (2.5Y 4/2) loamy sand; single grain; loose; medium acid.

C2—26 to 33 inches, variegated dark grayish-brown (2.5Y 4/2), olive-brown (2.5Y 4/4), and light olive-brown (2.5Y 5/4) coarse and medium sand; single grain; loose; medium acid.

C3—33 to 48 inches, variegated grayish-brown (2.5Y 5/2), light olive-brown (2.5Y 5/4), olive-brown (2.5Y 4/4), and dark grayish-brown (2.5Y 4/2) coarse sand; single grain; loose; medium acid.

The surface layer generally is sandy loam. In thickness the A horizon ranges from 12 to 24 inches. The sandy loam part of the solum ranges from 18 to 36 inches in thickness. Depth to the substratum of sand and gravel ranges from 24 to 42 inches. This substratum is mainly coarse and medium sand. In places the lower part of the B horizon and the sandy substratum have variable mottles of light olive brown, olive, or dark yellowish brown. The Duelm soils are neutral to medium acid to a depth of more than 28 inches.

DUNDAS SERIES

Soils of the Dundas series are deep, level and nearly level, and somewhat poorly drained to poorly drained. They are mainly on ground moraines in the county. These soils formed in friable, calcareous, grayish loam to clay loam glacial till of late Wisconsin age. Originally the vegetation was deciduous hardwood forest, but grass encroached in places. The areas have many microrelief depressions.

Dundas soils have drainage similar to that of the Ames soils, but they have a thicker, darker A1 horizon and generally have a darker gray A2 horizon. They are similar to the poorly drained Cordova soils, but they have a somewhat thinner, lighter colored, more silty A1 horizon. They also have a very distinct A2 horizon, and Cordova soils lack this horizon or have only an indistinct one. All three of these soils show a marked increase in clay content between the A and C horizons.

Representative profile of Dundas silt loam on a slope of 1 percent in a bluegrass pasture (NW¼NW¼ sec. 2, T. 119 N., R. 25 W.):

A1—0 to 4 inches, black (N 2/0) silt loam; moderate, very fine, subangular blocky structure; friable when moist, slightly plastic when wet; large amount of organic matter and thick, matted roots; slightly acid; clear, smooth boundary.

A21—4 to 7 inches, very dark gray (10YR 3/1), very dark gray (10YR 3/1, dry) to dark-gray (10YR 4/1, dry) heavy silt loam; weak to moderate, very thin, platy structure; friable when moist, slightly plastic and slightly sticky when wet; medium acid; clear, smooth boundary.

B1—7 to 10 inches, dark-gray (10YR 4/1), gray (10YR 5/1, dry) silty clay loam; moderate, very fine, subangular blocky structure; friable when moist, slightly plastic to plastic and slightly sticky when wet; strongly acid; clear, smooth boundary.

B21g—10 to 14 inches, very dark gray (2.5Y to 10YR 3/1) silty clay; common, fine, faint mottles of dark grayish brown (2.5Y 4/2); moderate to strong, subangular blocky structure; continuous, distinct clay films on vertical faces and patches of clay on horizontal faces; very firm when moist, plastic and sticky when wet; strongly acid; clear, smooth boundary.

B22g—14 to 19 inches, dark grayish-brown (2.5Y 4/2) silty clay; strong, very fine, subangular and angular blocky structure; continuous, distinct clay films on all faces of peds; a few very dark brown (10YR 2/2) organic stains; very firm when moist, plastic and sticky when wet; strongly acid; clear, smooth boundary.

B23g—19 to 26 inches, olive (5Y 4/3) silty clay; weak, fine, prismatic structure that breaks to strong, very fine, angular and subangular blocky structure; continuous, distinct clay films on all faces of peds; a few very dark brown (10YR 2/2) organic stains; very firm when moist, plastic and sticky when wet; strongly acid; clear, smooth boundary.

B24g—26 to 34 inches, dark grayish-brown (2.5Y 4/2) to olive-gray (5Y 4/2) silty clay; common, fine, faint mottles of olive (5Y 5/3); moderate, medium, prismatic structure that breaks to strong, fine and medium, angular blocky structure; continuous, distinct clay films on all faces of peds; thick, continuous, very dark brown (10YR 2/2) organic stains; very firm when moist, plastic and sticky when wet; medium acid; clear, smooth boundary.

B3g—34 to 39 inches, olive-gray (5Y 4/2) and dark-gray (5Y 4/1) clay loam; many, fine, distinct mottles of olive (5Y 5/3 and 5/4); massive; friable to firm; a few very dark brown (10YR 2/2) organic stains and reddish and orange iron stains; slightly acid; clear, smooth boundary.

C1g—39 to 42 inches, olive-gray (5Y 5/2) light clay loam or loam; many, fine, distinct mottles of olive (5Y 5/3, 5/4, and 5/6); massive; friable when moist, slightly plastic and slightly sticky when wet; many very dark brown (10YR 2/2) organic stains along root channels and cleavage planes and reddish and orange iron stains; many lime pebbles; slightly calcareous; clear, smooth boundary.

C2g—42 to 60 inches, olive-gray (5Y 5/2) light clay loam or loam; many, fine, distinct mottles of olive (5Y 5/3, 5/4, and 5/6); massive; friable when moist, slightly plastic and slightly sticky when wet; many very dark brown (10YR 2/2) organic stains in old root channels; calcareous.

The A horizon generally is silt loam, but in small included areas it is silty clay loam. The thickness of the A1 horizon is 3 to 8 inches. The A2 horizon is 1 to 6 inches thick and has platy structure. The B2 horizon ranges from heavy clay loam to clay but generally is silty clay. It has moderate to strong, very fine, fine, and medium, blocky structure to moderate, medium, prismatic structure and patchy to continuous clay films. The C horizon generally is friable loam or clay loam glacial till, but in a few areas it is deep, firm silty clay till. The A horizon is neutral to medium acid. The B2 horizon is slightly acid to very strongly acid but generally is medium acid to strongly acid. Depth to calcareous underlying material is 30 to 40 inches and generally is more than 36 inches. In places stones and boulders are on the surface and in the soils, and variable amounts of shale fragments also are on and in the soils.

EMMERT SERIES

The Emmert series consists of shallow and very shallow, rolling to very steep, excessively drained and somewhat excessively drained soils. These soils are on a small, irregular terminal moraine in the north-central part of the county. They formed in reddish-brown, acid, sandy and gravelly glacial till of Cary time. The native vegetation was a deciduous hardwood forest made up mainly of oak and aspen but that included a few elm, ash, and basswood trees.

Emmert soils are shallower and more excessively drained than the Burnsville soils, which formed in grayish, calcareous, sandy and gravelly glacial drift. They are associated with the well-drained Milaca soils but formed in shallower and coarser textured material.

Representative profile of Emmert sandy loam on a slope of 5 percent in a bluegrass pasture (SE¼NE¼ sec. 10, T. 121 N., R. 26 W.):

A1—0 to 4 inches, black (10YR 2/1) sandy loam; weak, fine and very fine, granular structure; very friable; slightly acid; clear, wavy boundary.

AC1—4 to 8 inches, very dark grayish-brown (10YR 3/2) to dark-brown (10YR 3/3) loamy sand; weak, very fine and fine, granular structure; very friable; slightly acid; clear, wavy boundary.

AC2—8 to 11 inches, dark-brown (10YR 3/3) medium and coarse loamy sand; single grain; loose; slightly acid; clear, wavy boundary.

IIC1—11 to 17 inches, dark-brown (10YR 4/3) to dark yellowish-brown (10YR 4/4), fine and coarse gravel and coarse and medium sand; single grain; weakly cemented; slightly acid; clear, wavy boundary.

IIC2—17 to 31 inches, dark-brown (10YR 4/3) to dark yellowish-brown (10YR 4/4) fine and medium gravel and coarse sand; single grain; loose; slightly acid; gradual, wavy boundary.

IIC3—31 to 34 inches, dark yellowish-brown (10YR 4/4) to dark-brown (7.5YR 4/4) very weak, loamy coarse sand with some gravel; single grain; loose; slightly acid; gradual, wavy boundary.

IIIC4—34 to 43 inches, dark reddish-brown (5YR 3/4) and reddish-brown (5YR 4/4) loamy coarse sand and coarse sandy loam with some gravel; coherent lumps break under slight pressure; slightly acid; gradual, wavy boundary.

IIIC5—43 to 55 inches, dark-brown (7.5YR 4/4) and reddish-brown (5YR 4/4) coarse sand and fine gravel; single grain; loose; slightly acid.

The surface layer generally is sandy loam and gravelly sandy loam, but in some areas it is loamy sand. The sandy loams generally are on undulating to strongly rolling areas, and the coarser textured gravelly sandy loams are on steep and very steep ridges and hills. The Emmert sandy loams are 10 to 24 inches thick over sand and gravel. In places thin layers of reddish loamy sand to clay loam are at a depth of 30 to 48 inches. The gravelly sandy loams and loamy sands are very shallow over sand and gravel. Many large stones and boulders are on and in all of these soils. The profile and the underlying material are slightly acid to medium acid. In places the underlying material is mixed with grayish, calcareous drift.

ESTHERVILLE SERIES

The Estherville series consists of shallow, nearly level to strongly sloping and hilly, somewhat excessively drained soils on outwash plains and stream terraces. These soils formed under tall prairie grasses over calcareous, grayish-brown gravel and sand.

Estherville soils are associated with the well-drained Wadena soils but are shallower to sand and gravel. Their drainage is similar to that of the Hubbard soils, but those soils formed in deep, noncalcareous sand and have a more sandy solum.

Representative profile of Estherville sandy loam in a bluegrass pasture on a slope of 1 percent (NW¼NE¼ sec. 11, T. 122 N., R. 27 W.):

Ap—0 to 7 inches, black (10YR 2/1) sandy loam; moderate, fine, granular structure; very friable; very slightly acid; clear, smooth boundary.

A12—7 to 9 inches, black (10YR 2/1) sandy loam; moderate, fine, granular structure; very friable; very slightly acid; clear, smooth boundary.

A13—9 to 11 inches, black (10YR 2/1) and very dark brown (10YR 2/2) sandy loam; weak, very fine and fine, granular structure; very friable; very slightly acid; clear, smooth boundary.

B2—11 to 16 inches, dark-brown (10YR 3/3 to 7.5YR 3/2) sandy loam or weak loam; weak, very fine, subangular blocky structure; friable; very slightly acid; clear, smooth boundary.

IIB3—16 to 19 inches, dark-brown (10YR 4/3 to 7.5YR 4/2) loamy coarse sand; single grain; loose; slightly acid; clear, smooth boundary.

IIC1—19 to 32 inches, dark-brown (10YR 4/3) and dark yellowish-brown (10YR 4/4) fine and coarse gravel and coarse sand; slightly acid; clear, smooth boundary.

IIC2—32 to 42 inches, dark grayish-brown (10YR 4/2), dark-brown (10YR 4/3), and brown (10YR 5/3) fine and coarse gravel and coarse sand; single grain; loose; calcareous.

The surface layer generally is sandy loam or loam, but sandy loam predominates. In the loams the B2 horizon is also loam, and in the sandy loams it is sandy loam or a weak loam. Both are underlain by gravel and sand at a depth of 10 to 24 inches. The loams generally are 18 to 20 inches thick over gravel, and the sandy loams generally are underlain by gravel at a depth of 15 to 18 inches. The solum is slightly acid to medium acid. In places the upper part of the underlying material is leached of free carbonates, but in most places it is calcareous at a depth of 30 to 36 inches.

FAIRHAVEN SERIES

The Fairhaven series consists of moderately deep, nearly level to rolling, well-drained, silty soils on outwash plains and terraces. These soils are underlain by loose, calcareous sand and gravel at a depth of 24 to 42 inches. The native vegetation was tall prairie grass. In this county Fairhaven soils occupy small areas mainly on outwash plains of the Clearwater and Mississippi Rivers.

Fairhaven soils have drainage similar to that of the Wadena soils and the variants from the Sattre series. They are closely associated with the Wadena soils, but their solum is more silty. They have a thicker A1 horizon than the Sattre variants and lack an A2 horizon, which is incipient to distinct in the Sattre. Also their B horizon is not so well developed.

Representative profile of Fairhaven silt loam in a soybean field on a slope of 1 percent (SE¼SW¼ sec. 17, T. 121 N., R. 27 W.):

A1p—0 to 9 inches, black (10YR 2/1) silt loam; cloddy; friable; slightly acid; abrupt, smooth boundary.

B1—9 to 14 inches, very dark grayish-brown (10YR 3/2) silt loam; weak, medium, subangular blocky structure that breaks to weak, very fine, subangular blocky structure; friable; slightly acid; clear, smooth boundary.

B21—14 to 19 inches, dark grayish-brown (10YR 4/2) silt loam; weak, medium, subangular blocky structure that breaks to weak, very fine and fine, subangular blocky structure; friable; a few small pebbles; slightly acid; clear, smooth boundary.

B22—19 to 24 inches, dark grayish-brown (10YR 4/2) silt loam that grades to dark-brown (10YR 4/3) silt loam; weak, medium, subangular blocky structure that breaks to weak, very fine and fine, subangular blocky structure; friable; a few small pebbles; slightly acid; clear, smooth boundary.

IIB3—24 to 27 inches, brown (10YR 4/3) and yellowish-brown (10YR 5/4) gravelly sandy loam that grades to gravelly loamy sand; massive; very friable; slightly acid; clear, smooth boundary.

IIC—27 to 42 inches, variegated grayish-brown (10YR 5/2), brown (10YR 5/3), yellowish-brown (10YR 5/4), and pale-brown (10YR 6/3) coarse sand and gravel; single grain; loose; calcareous.

The A horizon generally is silt loam, but in small areas it is nearly loam or is light silty clay loam. It ranges from 7 to 10 inches in thickness and is black to very dark brown in color. The B horizon is silt loam or silty clay loam that has weak blocky structure and has little or no more clay than the A horizon. Its color has a hue of 10YR, a value of 4 or 5, and a chroma that ranges from 2 to 4. Loose, stratified sand and gravel are within a depth of 24 to 42 inches. The A horizon is neutral to slightly acid, and the B horizon is neutral to medium acid. In places the underlying material is leached of free carbonates in the upper part but is calcareous within a depth of 40 inches. In a few places cobblestones and other stones are in the solum and substratum.

GLENCOE SERIES

Soils of the Glencoe series are deep and are very poorly drained. They are in depressions and drainageways within the glacial uplands of the county. These soils formed under marsh grasses in calcareous, grayish silty clay loam and clay loam glacial till of late Wisconsin age.

Glencoe soils occupy lower areas than the poorly drained Webster soils, and they have a thicker A horizon and more distinctly gleyed underlying material. They have drainage similar to that of the Talcot soils, which are underlain by sand and gravel.

Representative profile of Glencoe silty clay loam in a basinlike depression on a slope of less than 1 percent under marsh grasses, reeds, and sedges (NW¼SE¼ sec. 26, T. 118 N., R. 26 W.):

OO—0 to 6 inches, black (10YR 2/1) peat; weak, very fine and fine, granular structure; friable; slightly calcareous; gradual, wavy boundary.

A1—6 to 12 inches, black (N 2/0 to 5Y 2/1) silty clay loam; moderate, very fine, subangular blocky structure; firm when moist, very plastic when wet; slightly calcareous; gradual, wavy boundary.

A3—12 to 21 inches, black (5Y 2/1) silty clay loam; common, fine, faint mottles of dark olive gray (5Y 3/2); massive; firm when moist, very plastic when wet; slightly calcareous; gradual, wavy boundary.

Bg1—21 to 25 inches, very dark gray (5Y 3/1) silty clay loam; common fine, faint mottles of olive gray (5Y 4/2); massive; firm when moist, very plastic when wet; neutral; gradual, wavy boundary.

Bg2—25 to 36 inches, olive-gray (5Y 5/2) silty clay loam; many, medium, prominent mottles of olive (5Y 5/4 and 5/6); massive; firm when moist, plastic and sticky when wet; many reddish iron stains; neutral; gradual, wavy boundary.

Cg1—36 to 44 inches, olive-gray (5Y 4/2 and 5/2) silty clay loam or clay loam; many, fine, distinct mottles of olive (5Y 5/3, 5/4, and 5/6); massive; firm when moist, plastic and sticky when wet; pronounced reddish iron stains; a few lime pebbles; slightly calcareous; gradual, wavy boundary.

Cg2—44 to 54 inches, olive-gray (5Y 4/2 and 5/2) clay loam; many, fine, distinct mottles of olive (5Y 5/4 and 5/6); massive; plastic and sticky when wet; pronounced reddish iron stains; a few lime pebbles; calcareous.

The A horizon generally is silty clay loam, but it is silt loam in small areas. In many places a layer of peat or muck as much as 12 inches thick covers the surface soil. The A horizon is 18 to 30 inches thick and generally contains silty sediments recently washed onto the areas from surrounding slopes. The underlying material is characteristically olive-gray silty clay loam and clay loam. The A horizon and material just below are slightly acid to mildly alkaline, but generally the soils are moderately alkaline within a depth of 48 inches.

GUCKEEN SERIES

This series consists of very deep, nearly level to gently rolling, moderately well drained and somewhat poorly drained soils in the lake region in the northwestern part of the county. These soils formed in calcareous, olive-brown, fine-textured lacustrine deposits of late Wisconsin age. The original vegetation was prairie grass, but deciduous hardwood trees later encroached in some areas.

Guckeen soils are finer textured throughout the solum and underlying material than the variants from the Lester series, which are well drained. They also have a thicker A1 horizon. Their B horizon is finer textured than that of the moderately well drained Le Sueur soils, which formed in glacial till.

Representative profile of Guckeen silty clay loam in a cultivated field on a slope of 1 percent (NW¼NW¼ sec. 36, T. 121 N., R. 28 W.):

A1p—0 to 10 inches, (10YR 2/1) silty clay loam; weak to moderate, very fine, subangular blocky structure; friable when moist, plastic and sticky when wet; slightly acid.

A3—10 to 14 inches, black (5Y 2/1) and very dark grayish-brown (2.5Y 3/2) heavy silty clay loam; moderate, very fine, subangular blocky structure; friable and firm when moist, plastic and sticky when wet; slightly acid.

B21—14 to 21 inches, very dark grayish-brown (2.5Y 3/2) and dark grayish-brown (2.5Y 4/2) silty clay; moderate, very fine, subangular blocky structure; very firm when moist, plastic and sticky when wet; slightly acid.

B22—21 to 30 inches, dark grayish-brown (2.5Y 4/2) to olive-brown (2.5Y 4/4) silty clay; many, fine, distinct mottles of olive (5Y 5/3) and light olive brown (2.5Y 5/4); moderate to strong, very fine, subangular blocky structure; very firm when moist, plastic and sticky when wet; medium acid.

B23—30 to 35 inches, dark grayish-brown (2.5Y 4/2), grayish-brown (2.5Y 4/2), and light olive-brown (2.5Y 5/4) silty clay; moderate, very fine, subangular blocky structure; very firm when moist, plastic and sticky when wet; strongly acid.

B24—35 to 41 inches, light olive-brown (2.5Y 5/4) and grayish-brown (2.5Y 5/2) silty clay or heavy silty clay loam; massive; firm when moist, plastic and sticky when wet; medium acid.

B25—41 to 47 inches, light olive-brown (2.5Y 5/4) and grayish-brown (2.5Y 5/2) silty clay; massive; firm when moist, plastic and sticky when wet; slightly acid.

C—47 to 52 inches, light olive-brown (2.5Y 5/4) silty clay loam; massive; friable and firm when moist, plastic and sticky when wet; calcareous.

The A horizon generally is silty clay loam, but in a few areas it is heavy silt loam or light silty clay. It is 9 to 12 inches thick. The B2 horizon is silty clay or clay and has moderate to strong, very fine, subangular blocky structure. It is dark grayish brown (2.5Y 4/2) to grayish brown (2.5Y 5/2) and has variable mottles of olive brown (2.5Y 4/4) and light olive brown (2.5Y 5/4). In the area south of Union Lake, however, the soils are rolling and are olive gray (5Y 5/2) and olive (5Y 5/3). The combined thickness of the A and B horizons generally is 40 to 50 inches, but in the area south of Union Lake calcareous parent material is at a depth of 16 inches. The A horizon is slightly acid. The B horizon is slightly acid to very strongly acid but generally is medium acid to strongly acid. The calcareous underlying material generally consists of varved layers of silty clay, clay, and silty clay loam, but in some areas it is massive, fine-textured material. These soils generally have no stones on the surface or in the soil, but in places small nodules of lime are in the C horizon.

HAYDEN SERIES

Soils of the Hayden series are deep, undulating to hilly, and well drained. These soils occupy large areas on moraines in the county. They formed in friable, calcareous, grayish loam and clay loam glacial till of late Wisconsin age. The native vegetation was deciduous hardwood trees.

Hayden soils are closely associated with, formed in material similar to, and have drainage similar to that of the Lester soils, which formed partly under grass. They have a thinner A1 horizon and a more distinct A2 horizon than the Lester soils, and their B2 horizon is more clayey and has better structure. They are also closely associated with the moderately well drained Nessel soils and the poorly drained to somewhat poorly drained Dundas and Ames soils.

Representative profile of Hayden loam on a slope of 5 percent in a wooded and pastured area under elm, basswood, ironwood, and bluegrass vegetation (SE¼NW¼ sec. 26, T. 120 N., R. 26 W.) (profile 560 Minn., 86–2 (1–8), sampled for laboratory analysis):

A1—0 to 2 inches, very dark brown (10YR 2/2) loam; weak, very fine, granular structure; friable; slightly acid; abrupt, smooth boundary.

A2—2 to 7 inches, very dark gray (10YR 3/1) to dark-gray (10YR 4/1) loam, grayish brown (10YR 5/2, dry) to light brownish gray (10YR 6/2, dry); weak, thin, platy structure; friable; slightly acid; clear, smooth boundary.

A2 & B—7 to 10 inches, dark-gray (10YR 4/1) to dark grayish-brown (10YR 4/2) loam; moderate, fine, subangular blocky structure; thick, continuous, light brownish-gray (10YR 6/2, dry) silica coatings; firm; slightly acid; gradual, smooth boundary.

B21—10 to 15 inches, dark grayish-brown (10YR 4/2) clay loam; strong, fine, subangular blocky structure; continuous, distinct clay films on all faces of peds; light brownish-gray (10YR 6/2) silica coatings; firm; a few fine shale fragments; slightly acid; gradual, wavy boundary.

B22—15 to 22 inches, dark grayish-brown (10YR 4/2) to dark-brown (10YR 4/3) clay loam; strong, fine and medium, subangular blocky structure; continuous, distinct clay films on all faces of peds; light brownish-gray (10YR 6/2) silica coatings; firm; many fine shale fragments; medium acid; gradual, wavy boundary.

B23—22 to 32 inches, olive-brown (2.5Y 4/4) to light olive-brown (2.5Y 5/4) clay loam; very dark grayish-brown (10YR 3/2) organic coatings that are most prominent in old root channels; weak to moderate, coarse, prismatic structure that breaks to moderate to strong, medium and coarse, subangular blocky; continuous, distinct clay films on all faces of peds; firm; many small shale fragments; medium acid; clear, wavy boundary.

C1—32 to 39 inches, olive-brown (2.5Y 4/4) to light olive-brown (2.5Y 5/4) heavy loam; massive; friable; a few, small, reddish iron stains; many small lime pebbles; slight to strong effervescence with hydrochloric acid; gradual, smooth boundary.

C2—39 to 55 inches, light olive-brown (2.5Y 5/4) loam; massive; friable; light reddish iron stains and light horizontal seams and threads of light brownish-gray (2.5Y 6/2) segregated lime; many small shale fragments and lime pebbles; calcareous.

The surface layer generally is loam or fine sandy loam, but it is silt loam in small areas. Loam is predominant. The A1 horizon is less than 4 inches thick. The A2 horizon ranges from 2 to 6 inches in thickness and generally has platy structure, but in many places in the sandy loams it has weak granular structure.

Hayden loams have a B2 horizon of heavy clay loam. In the sandy loams the upper part of the B horizon is loam or sandy loam, but about midway in the solum the material is heavy loam to heavy clay loam. The B2 horizon of all Hayden soils is more clayey than the A and C horizons. Clay films generally are continuous on all faces of peds in the more strongly developed parts of the B horizon. The peds in the upper part of the B horizon generally have coatings of silica that filtered down from the A2 horizon. Pronounced, very dark brown organic stains are in the B2 horizon and protrude into old root channels in the C horizon. Structure of the B2 horizon ranges from moderate to strong, very fine, blocky to coarse prismatic.

The solum is 24 to 48 inches thick, and calcareous parent material generally is at a depth of 30 to 36 inches. The A horizon is slightly acid, and the B horizon is slightly acid to strongly acid. A few stones and boulders are on the surface and in the soil, and in places shale fragments occur in varying amounts.

HUBBARD SERIES

The Hubbard series consists of deep, nearly level to hilly, somewhat excessively drained and excessively drained soils. These soils occupy large areas on outwash plains and terraces of the Mississippi and Crow Rivers. They formed in noncalcareous sand of late Wisconsin age. The native vegetation was prairie grass.

Hubbard soils are deeper than the somewhat excessively drained Estherville soils and are leached of carbonates to a greater depth. They are closely associated with the well-drained, moderately deep Wadena soils but have a coarser textured solum and are more deeply leached.

Representative profile of Hubbard loamy sand in a cultivated field on a slope of 1 percent (SE¼NE¼ sec. 15, T. 122 N., R. 26 W.) (profile S60 Minn., 86–3 (1–6), sampled for laboratory analysis):

Ap—0 to 9 inches, black (10YR 2/1) loamy, medium and coarse sand; cloddy but breaks to single grain; very friable; medium acid; abrupt, smooth boundary.

AC—9 to 16 inches, dark yellowish-brown (10YR 3/4), weak, loamy, medium sand; single grain; coherent lumps break under slight pressure; medium acid; gradual, wavy boundary.

C1—16 to 24 inches, dark yellowish-brown (10YR 4/4 and 3/4) medium sand; single grain; coherent lumps break under very slight pressure; medium acid; gradual, wavy boundary.

C2—24 to 31 inches, dark yellowish-brown (10YR 4/4), medium sand; single grain; slightly coherent; medium acid; gradual, wavy boundary.

C3—31 to 42 inches, dark-brown (10YR 4/3) medium sand; single grain; very weakly cemented; medium acid; gradual, wavy boundary.

C4—42 to 62 inches, dark grayish-brown (10YR 4/2), dark-brown (10YR 4/3), and brown (10YR 5/3) coarse and medium sand that contains some fine gravel; single grain; loose; medium acid; gradual, wavy boundary.

IIC5—62 inches, grayish-brown (10YR 5/2) and brown (10YR 5/3) fine and medium gravel and coarse sand; single grain; loose; a few, small, lime pebbles; medium acid.

Representative profile of Hubbard sandy loam in a cultivated field on a slope of 1 percent (SE¼SE¼ sec. 15, T. 121 N., R. 23 W.):

Ap—0 to 8 inches, very dark gray (10YR 3/1) sandy loam; weak, fine, granular structure; very friable; medium acid; clear, smooth boundary.

A12—8 to 10 inches, very dark gray (10YR 3/1) sandy loam; weak, fine, granular structure; very friable; medium acid; clear, smooth boundary.

AC—10 to 15 inches, very dark grayish-brown (10YR 3/2) to dark-brown (7.5YR 3/2) sandy loam; massive; very friable; medium acid; gradual, wavy boundary.
IIC1—15 to 21 inches, dark-brown (10YR 3/3) loamy sand; single grain; loose; medium acid; gradual, wavy boundary.
IIC2—21 to 32 inches, dark-brown (10YR 4/3) and yellowish-brown (10YR 5/4) fine and medium sand; single grain; loose; medium acid; gradual, wavy boundary.
IIC3—32 to 47 inches, dark-brown (10YR 4/3) medium sand; single grain; loose; medium acid; gradual, wavy boundary.
IIC4—47 to 58 inches, dark-brown (10YR 3/3) coarse sand and fine gravel; single grain; loose; medium acid.

The surface layer is loamy sand or sandy loam. The loamy sands have a B2 horizon of sand or loamy sand. In the sandy loams the B2 horizon is sandy loam or loamy sand. Both of these are less than 24 inches deep to sand that contains a small amount of fine gravel. All of these soils are medium acid to strongly acid throughout the profile. Depth to calcareous sand generally is more than 60 inches.

HUBBARD SERIES, GRAVELLY SUBSOIL VARIANT

The variants from the normal Hubbard series are shallow, nearly level to gently rolling, and excessively drained. These soils are on outwash plains. They consist of loamy sands and formed under prairie grass over loose, brownish sand and gravel.

These variants are closely associated with the Hubbard and Estherville soils. They have drainage similar to that of the Hubbard soils, but have coarse sand and fine gravel within a depth of 12 to 24 inches. Unlike the Estherville soils, these variants have a sandy mantle over sand and gravel. They also are more deeply leached.

Representative profile of Hubbard loamy sand, gravelly subsoil variant, in a pasture on a slope of 2 percent (SW¼SE¼ sec. 3, T. 121 N., R. 25 W.):

Ap—0 to 9 inches, black (10YR 2/1) loamy sand; weak, very fine and fine, granular structure; very friable; slightly acid; abrupt, smooth boundary.
A12—9 to 14 inches, very dark brown (10YR 2/2) loamy sand; weak, very fine and fine, granular structure; very friable; slightly acid; clear, smooth boundary.
AC—14 to 19 inches, very dark grayish-brown (10YR 3/2) to dark-brown (10YR 3/3) light loamy sand; single grain; moderately coherent; slightly acid; gradual, smooth boundary.
IIC1—19 to 22 inches, dark-brown (10YR 3/3) medium and coarse sand; single grain; loose; slightly acid; gradual, smooth boundary.
IIC2—22 to 25 inches, dark-brown (10YR 4/3) coarse sand that contains a small amount of fine gravel; single grain; loose; slightly acid; clear, smooth boundary.
IIIC3—25 to 40 inches, dark-brown (10YR 4/3) gravel and coarse sand; single grain; loose; slightly acid; gradual, wavy boundary.
IIIC4—40 to 50 inches, dark-brown (10YR 4/3) and dark grayish-brown (10YR 4/2) gravel and coarse sand; single grain; loose; slightly calcareous.

In places the coarse underlying material is calcareous within a depth of 36 to 48 inches, but in some places this material is leached of free lime carbonates to a depth of more than 60 inches. The more deeply leached soils have an underlying layer of coarse sand and fine gravel that is 6 to 18 inches thick over sand that contains a small amount of fine gravel. Reaction ranges from slightly acid to medium acid to a depth of more than 36 inches.

LESTER SERIES

The Lester soils are deep and well drained. These soils are mostly on undulating to hilly ground and terminal moraines. They formed in friable, calcareous, grayish loam and clay loam glacial till of late Wisconsin age. Prairie grass was the original vegetation but was succeeded by deciduous hardwood trees.

Lester soils are closely associated with Hayden soils, have similar drainage, and formed in similar material. They have a thicker, darker colored A1 horizon, however, and a less distinct A2 horizon. They are also closely associated with the moderately well drained Le Sueur soils and the poorly drained Cordova.

Representative profile of Lester loam on a slope of 5 percent in a wooded pasture that includes many maple, red oak, elm, and ironwood trees (NE¼SE¼ sec. 34, T. 119 N., R. 26 W.):

A1—0 to 7 inches, black (10YR 2/1) loam; moderate, very fine, subangular blocky structure; friable; neutral; clear, wavy boundary.
A2—7 to 9 inches, very dark gray (10YR 3/1) to dark-gray (10YR 4/1) loam; weak, very fine, subangular blocky structure; very friable; neutral; clear, wavy boundary.
B1—9 to 13 inches, very dark grayish-brown (10YR 3/2) light clay loam; moderate, very fine, subangular blocky structure; peds have gray (10YR 5/1, dry) coatings; friable; slightly acid; clear, smooth boundary.
B21—13 to 21 inches, dark grayish-brown (10YR 4/2) clay loam; moderate to strong, fine, subangular blocky structure; ped exteriors have very dark grayish-brown (10YR 3/2) and very dark brown (10YR 2/2) organic stains and continuous, distinct clay films on all faces; firm; strongly acid; clear, smooth boundary.
B22—21 to 29 inches, dark grayish-brown (10YR 4/2) clay loam; moderate to strong, fine and medium, subangular blocky structure; ped exteriors have very dark grayish-brown (10YR 3/2) organic stains and continuous, distinct clay films on all faces; firm; a few fine shale fragments; strongly acid; clear, smooth boundary.
B23—29 to 39 inches, olive-brown (2.5Y 4/4) and yellowish-brown (10YR 5/4) light clay loam; moderate, medium, subangular blocky structure; very dark grayish-brown (10YR 3/2) organic stains and clay films on the faces of some peds and in old root channels; firm; a few fine shale fragments; medium acid; clear, smooth boundary.
C—39 to 45 inches, light olive-brown (2.5Y 5/4), olive-brown (2.5Y 4/4), and grayish-brown (2.5Y 5/2) light clay loam; massive; friable; a few reddish-brown iron stains; many lime pebbles; calcareous.

The A horizon is dominantly loam, but it is silt loam and light clay loam in small areas. In uneroded areas the A1 horizon ranges from 5 to 9 inches in thickness, but it generally is 6 to 8 inches thick. The A2 horizon is incipient to fairly distinct and is 1 to 4 inches thick. It has weak, very fine, subangular blocky structure to weak, thin, platy.

The B horizon generally is clay loam, but in a few areas it is heavy loam. Its structure ranges from moderate to strong, fine and medium, blocky to fine and medium, prismatic. Patchy to continuous clay films are on the peds. In the upper part of the B horizon the peds have coatings of silica that filtered down from the A2 horizon.

The solum is 20 to 48 inches thick, but calcareous parent material generally is within a depth of 30 to 36

inches. The A horizon is neutral to slightly acid, and the B horizon is slightly acid to strongly acid. Depth to calcareous underlying material ranges from 30 to 48 inches but generally is 30 to 40 inches. A few stones and boulders are on the surface and in the soil. In places shale fragments occur in varying amounts.

LESTER SERIES, SILTY VARIANT

The variants from the normal Lester series are very deep and are well drained. These soils are on gently undulating to rolling slopes south of Clearwater Lake. They formed in water-laid, calcareous, olive-brown lacustrine silt. The native vegetation was grass and various kinds of deciduous hardwoods.

These variants are near the poorly drained Webster, silty variants. They are somewhat similar to the well-drained Sattre, silty variants, which formed in moderately deep, silty material over sand and gravel. They have drainage similar to that of the normal Lester soils, which formed from glacial till.

Representative profile of Lester silt loam, silty variant, in a deciduous hardwood forest, mostly maple and elm, on a slope of 4 percent (SE¼SE¼ sec. 20, T. 121 N., R. 27 W.):

A1—0 to 3½ inches, very dark gray (10YR 3/1) silt loam; moderate, very fine, granular structure; friable when moist, slightly plastic when wet; neutral; clear, smooth boundary.

A21—3½ to 7 inches, very dark gray (10YR 3/1) to dark-gray (10YR 4/1) silt loam, dark-gray (10YR 4/1) to gray (10YR 5/1, dry); weak to moderate, very fine, granular structure; horizontal cleavage; very friable when moist, slightly plastic when wet; neutral; clear, smooth boundary.

A22—7 to 10 inches, dark-gray (10YR 4/1) silt loam, gray (10YR 5/1, dry); weak, very fine, granular structure; horizontal cleavage; very friable when moist, slightly plastic when wet; neutral; clear, smooth boundary.

B1—10 to 15 inches, dark grayish-brown (10YR 4/2) silty clay loam; exterior dark-gray (10YR 4/1) and gray (10YR 5/1) to light-gray (10YR 6/1, dry) silica coatings; weak to moderate, very fine and fine, subangular blocky structure; friable when moist, plastic when wet; slightly acid; clear, smooth boundary.

B21—15 to 21 inches, dark grayish-brown (10YR 4/2) silty clay loam that is finer textured than that in the B1 horizon; exterior dark-gray (10YR 4/1) and gray (10YR 5/1) to light-gray (10YR 6/1, dry) silica coatings; moderate, fine, subangular blocky structure; friable to firm when moist, plastic when wet; medium acid; gradual, smooth boundary.

B22—21 to 28 inches, light olive-brown (2.5Y 5/4) to olive-brown (2.5Y 4/4) silty clay loam; some peds have dark-brown (10YR 4/3) interiors and dark-gray (10YR 4/1) to dark grayish-brown (10YR 4/2) coatings; moderate, fine, subangular blocky structure; friable to firm when moist, very plastic when wet; medium acid; gradual, smooth boundary.

B23—28 to 38 inches, light olive-brown (2.5Y 5/4) silty clay loam; very dark grayish-brown (10YR 3/2) coatings on some peds; weak to moderate, very fine and fine, subangular blocky structure; friable when moist, plastic when wet; medium acid; clear, wavy boundary.

C1—38 to 43 inches, variegated light olive-brown (2.5Y 5/4 and 5/6), light brownish-gray (2.5Y 6/2), and grayish-brown (2.5Y 5/2) silty clay loam; black (10YR 2/1) and very dark brown (10YR 2/2) organic stains; massive; friable when moist, plastic when wet; calcareous; clear, wavy boundary.

C2—43 to 50 inches, variegated light olive-brown (2.5Y 5/4 to 5/6), grayish-brown (2.5Y 5/2), and light brownish-gray (2.5Y 6/2) silty clay loam; varved; very friable when moist, slightly plastic when wet; strongly calcareous.

The A horizon generally is silt loam, but it is sandy loam in a few places. Most areas of these soils have been cleared for cultivation. A few areas remain in forest or have not been cultivated. In these areas the A1 horizon is less than 4 inches thick. The A2 horizon is 2 to 8 inches thick and has weak, very thin, platy to granular structure.

The B2 horizon ranges from silt loam to silty clay loam and has moderate to strong, very fine and fine, subangular blocky structure. The peds in the upper part of this horizon have grayish (10YR 5/1) silica coatings, but in the lower part patchy to continuous clay films are on the peds.

The combined thickness of the A and B horizons ranges from 24 to 40 inches. The A horizon is neutral to slightly acid, and the B horizon is slightly acid to medium acid. The underlying material is strongly calcareous.

LE SUEUR SERIES

Soils of the Le Sueur series are deep, nearly level to undulating, and moderately well drained. These soils are on ground moraines, mostly in the southwestern part of the county. They formed in friable, calcareous, grayish clay loam glacial till of late Wisconsin age. The vegetation originally was prairie grasses, but deciduous hardwood trees encroached, and these trees covered the soils at time of settlement.

Le Sueur soils are closely associated with the well-drained Lester soils and the poorly drained Cordova and Webster. They have a thicker A1 horizon than the Lester soils, and unlike those soils, have mottling in the B2 horizon. Their solum lacks the distinctive olive-gray coloring of the Cordova and Webster soils and is less intensively mottled. Le Sueur soils have drainage similar to that of the Nessel soils, but they have a darker, thicker A1 horizon and a less distinct A2 horizon.

Representative profile of Le Sueur clay loam in a wooded pasture of elm, ash, and bluegrass on a slope of 1 percent. (NW¼SW¼ sec. 24, T. 118 N., R. 26 W.):

A1—0 to 9 inches, black (10YR 2/1) light clay loam; moderate, very fine, subangular blocky structure; friable; high organic matter content; slightly acid; clear, wavy boundary.

A2—9 to 11 inches, very dark gray (10YR 3/1) to dark-gray (10YR 4/1) light-textured clay loam; weak, very fine, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

B21—11 to 17 inches, very dark grayish-brown (10YR 3/2) and very dark brown (10YR 2/2) clay loam; moderate, fine, subangular blocky structure; gray (10YR 5/1) silica coatings; firm; strongly acid; gradual, wavy boundary.

B22—17 to 27 inches, dark grayish-brown (2.5Y 4/2) clay loam; few, fine, distinct mottles of light olive brown (2.5Y 5/4); moderate, fine and medium, angular blocky structure; continuous, distinct clay films on vertical faces of peds and patches on the horizontal faces; firm; strongly acid; clear, smooth boundary.

B23—27 to 34 inches, dark grayish-brown (2.5Y 4/2) clay loam; a few, fine, distinct mottles of light olive brown (2.5Y 5/4 and 5/6); weak, fine, angular blocky structure; patches of clay on vertical faces of peds; seams and blotches of very dark brown organic stains

in old root channels; firm; medium acid; clear, smooth boundary.

C1—34 to 37 inches, variegated grayish-brown (2.5Y 5/2) and light olive-brown (2.5Y 5/4 and 5/6) clay loam; massive; firm to friable; many, very dark brown (10YR 2/2) organic stains; calcareous.

C2—37 to 45 inches, grayish-brown (2.5Y 5/2) clay loam; many, medium, prominent mottles of light olive-brown (2.5Y 5/4 and 5/6); massive; friable; many lime pebbles; calcareous.

The A1 horizon generally is clay loam, but it is silty clay loam in places. It ranges from 9 to 12 inches in thickness. The A2 horizon is incipient to fairly distinct and is 1 to 3 inches thick. It has weak, very fine, subangular blocky structure to weak, thin, platy.

The B2 horizon contains more clay than the A and C horizons. It generally is clay loam to heavy clay loam in texture, but in a few areas it is a light clay. Structure of the B2 horizon ranges from moderate to strong, fine and medium, blocky to fine and medium, prismatic. Patchy to continuous clay films are on the faces of the peds. The peds in the upper part of the B horizon generally have silica coatings on them that have filtered down from the A2 horizon.

The solum is 30 to 48 inches thick. Calcareous parent material generally is at a depth of about 36 inches. The A horizon is slightly acid. The B2 horizon is slightly acid to strongly acid but generally is medium acid to strongly acid. A few stones and boulders are on the surface and in the soil. Shale fragments occur in varying amounts.

MARNA SERIES

Soils of the Marna series are deep and poorly drained. These soils are in the upland, mostly in the southwestern part of the county, on nearly level flats and in slightly depressed areas in drainageways. They formed in grayish lacustrine clay deposited over calcareous glacial till. The native vegetation was grass, but deciduous hardwood trees encroached in some areas.

Marna soils are closely associated with the Guckeen and Webster soils. They are not so well drained as the Guckeen and have a finer textured subsoil than the Webster. They are similar to the Cordova soils, but those soils have a fine-textured B2 horizon and in many places an incipient to fairly distinct A2 horizon.

Representative profile of Marna silty clay loam in a cultivated field on a slope of 1 percent (SE¼SE¼ sec. 25, T. 119 N., R. 28 W.):

Ap—0 to 8 inches, black (N 2/0) silty clay loam; cloddy; firm and friable when moist, plastic and sticky when wet; neutral.

A1—8 to 11 inches, black (N 2/0) silty clay; weak to moderate, very fine, subangular blocky structure; firm when moist, plastic and sticky when wet; neutral.

A3—11 to 13 inches, black (10YR 2/1) silty clay; a few, fine, faint mottles of dark olive gray (5Y 3/2) and olive gray (5Y 4/2); weak to moderate, very fine, subangular blocky structure; firm when moist, plastic and sticky when wet; neutral.

ACg1—13 to 17 inches, very dark gray (5Y 3/1) silty clay; many, fine, distinct mottles of olive gray (5Y 4/2) and olive (5Y 4/3); weak to moderate, very fine, subangular blocky structure; firm when moist, plastic and sticky when wet; neutral.

ACg2—17 to 22 inches, dark-gray (5Y 4/1) and olive-gray (5Y 4/2 and 5/2) silty clay; tongues of very dark gray (5Y 3/1); massive; firm when moist, plastic and sticky when wet; neutral.

ACg3—22 to 28 inches, olive-gray (5Y 4/2) silty clay; many, fine, distinct mottles of olive (5Y 4/3 and 5/3); tongues of dark gray (5Y 4/1) and very dark gray (5Y 3/1); massive; firm when moist, plastic and sticky when wet; neutral.

Cg1—28 to 30 inches, olive-gray (5Y 5/2) and gray (5Y 5/1) heavy silty clay loam; light-gray (5Y 6/1) streaks of lime; massive; friable and firm when moist, plastic and sticky when wet; calcareous.

Cg2—30 to 36 inches, light-gray (5Y 6/1) to light olive-gray (5Y 6/2) silty clay loam; massive; friable when moist, plastic and slightly sticky when wet; a few lime nodules; calcareous.

Cg3—36 to 48 inches, olive-gray (5Y 5/2) clay loam; many, fine, distinct mottles of olive (5Y 5/3); light-gray (5Y 6/1) feathered lime; massive; friable when moist, slightly plastic and slightly sticky when wet; a few lime nodules and many reddish-orange iron stains; calcareous.

The A horizon is silty clay loam in most places, but it is silty clay in many places. It is black to very dark gray and is 10 to 16 inches thick. The B horizon is silty clay or clay and has weak to moderate blocky structure. Calcareous loam or clay loam glacial till is generally at a depth of 24 to 48 inches. The A and B horizons are neutral to slightly acid. Boulders, evidently rafted in by ice, are on the surface in a few places but seldom are in the solum.

MILACA SERIES

The Milaca series consists of deep, well-drained, undulating to very steep soils on moraines that have irregular slopes. These soils are in a small area in the eastern part of Silver Creek Township. They formed partly in reddish-brown, acid, medium-textured to moderately fine textured glacial till and partly in water modified material of Cary age. The native vegetation was a deciduous hardwood forest consisting mostly of aspen and oak but that included a few elm, ash, and basswood.

Milaca soils are closely associated with the somewhat excessively drained to excessively drained Emmert soils, which formed over reddish-brown, acid, sandy and gravelly drift. They have drainage similar to that of the Hayden soils, which formed in grayish, calcareous loam or clay loam till, but Milaca soils have brownish or reddish-brown B and C horizons rather than yellowish brown.

Representative profile of Milaca loam in a cultivated field on a slope of 5 percent (SW¼SW¼ sec. 11, T. 121 N., R. 26 W.):

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) loam; cloddy; friable to firm; slightly acid; clear, wavy boundary.

B1—8 to 12 inches, dark grayish-brown (10YR 4/2) loam; moderate, fine and very fine, subangular blocky structure; friable; medium acid; clear, wavy boundary.

B21—12 to 20 inches, dark-brown (7.5YR 4/4) loam; heavy light brownish-gray (10YR 6/2, dry) silica coatings; firm; medium acid; clear, wavy boundary.

B22—20 to 25 inches, dark-brown (7.5YR 4/4) sandy clay loam; light brownish-gray (10YR 6/2, dry) silica coatings; moderate, fine and very fine, subangular blocky structure; firm; medium acid; gradual, wavy boundary.

B23—25 to 34 inches, dark-brown (7.5YR 4/4) sandy clay loam; moderate, very fine and fine, subangular blocky structure; firm; a few orange iron stains; medium acid; gradual, wavy boundary.

B24—34 to 39 inches, dark-brown (7.5YR 4/3) silty clay loam; moderate, very fine and fine, subangular blocky structure; firm and friable when moist, plastic when wet; medium acid; clear, wavy boundary.

C1—39 to 52 inches, dark reddish-brown (5YR 3/4) weak, loamy, medium sand; single grain; coherent lumps break under slight pressure; slightly acid; clear, wavy boundary.
C2—52 to 56 inches, reddish-brown (5YR 4/3) silty clay loam; varved; firm to friable when moist, plastic when wet; neutral to slightly calcareous.

The A horizon generally is loam, but it is sandy loam in small areas. It is less than 3 inches thick. The A2 horizon generally is loam or sandy clay loam and has moderate, subangular blocky structure. The lower part of the B2 horizon and the underlying C horizon generally are silty clay loam. The B and C horizons range from dark brown (7.5YR 4/4 and 3/2) to dark reddish brown (5YR 3/4 and 4/3) in color. Silica coatings are in the upper part of the B2 horizon. The soils are slightly acid to medium acid to a depth of more than 50 inches. A few stones and boulders are on the surface and in the soil.

The Milaca soils are currently under study, and the name Milaca may not be retained for these soils as described in Wright County.

NESSEL SERIES

The Nessel series consists of deep, nearly level to gently undulating, moderately well drained soils. These soils are on ground moraines, mostly in the northeastern part of the county. They formed in friable, calcareous, grayish glacial till of late Wisconsin age. The native vegetation was a deciduous hardwood forest.

Nessel soils are closely associated with the Hayden soils and formed in similar material, but they are not so well drained and, unlike those soils, their B2 horizon is faintly mottled. They are also closely associated with the somewhat poorly drained to poorly drained Ames soils. Nessel soils are similar to the moderately well drained to somewhat poorly drained Le Sueur soils, but they have a thinner, lighter colored A horizon and a more distinct A2 horizon.

Representative profile of Nessel loam in a bluegrass pasture on a slope of 2 percent (SW¼SE¼ sec. 1, T. 120 N., R. 24 W.):

A1—0 to 2 inches, very dark gray (10YR 3/1) loam; weak to moderate, very fine, subangular blocky structure; friable; medium acid; abrupt, smooth boundary.
A21—2 to 9 inches, dark-gray (10YR 4/1), light-gray (10YR 7/1, dry) loam; moderate, thin, platy structure; friable; medium acid; clear, smooth boundary.
A22—9 to 15 inches, grayish-brown (10YR 5/2), light-gray (10YR 7/1 and 7/2, dry) loam; weak, thick, platy structure that breaks to weak, medium, subangular blocky; friable; medium acid; clear, wavy boundary.
B1—15 to 18 inches, dark-brown (10YR 4/3) heavy loam; dark-gray and grayish-brown (10YR 4/1 and 5/2) silica coatings; weak to moderate, medium, subangular blocky structure; friable; medium acid; clear, smooth boundary.
B21—18 to 28 inches, dark yellowish-brown (10YR 3/4) heavy clay loam; a few, fine, faint mottles of light olive brown (2.5Y 5/4); strong, medium, angular blocky structure; continuous grayish-brown (10YR 5/2) clay films; very firm; strongly acid; clear, smooth boundary.
B22—28 to 35 inches, olive-brown (2.5Y 4/4) heavy clay loam; a few, fine, faint mottles of light olive brown (2.5Y 5/4); weak to moderate, prismatic structure that breaks to moderate, medium, subangular and blocky; continuous black (10YR 2/1) and very dark brown (10YR 2/2) clay films; very firm; strongly acid; clear, smooth boundary.
C1—35 to 39 inches, light olive-brown (2.5Y 5/4 and 5/6) loam; massive; friable; slightly acid; clear, smooth boundary.
C2—39 to 45 inches, light olive-brown (2.5Y 5/4 and 5/6) loam; a few, fine, distinct mottles of reddish brown; massive; friable; calcareous.

The A1 horizon generally is loam, but it is silt loam in a few areas. It is less than 3 inches thick and generally is 1 to 2 inches thick. The A2 horizon is 5 to 15 inches thick and has weak to moderate, very thin to thick, platy structure.

The B2 horizon is heavy clay loam that has moderate to strong, blocky structure or weak to moderate, fine and medium, prismatic structure breaking to blocky. In the upper part of the B horizon the peds generally have grayish silica coatings that filtered down from the A2 horizon. In the B2 horizon patchy to continuous clay films are on the faces of the peds. Faint, light olive-brown mottles are in the lower part of the B2 horizon and in places occur throughout this horizon.

Nessel soils are slightly acid to medium acid in the A horizon. The B horizon ranges from medium acid to very strongly acid and generally is medium acid to strongly acid. The combined thickness of the A and B horizons ranges from 30 to 48 inches. The calcareous loam or clay loam C horizon generally is at a depth of about 36 inches. In places a few stones and boulders are on the surface and in the soil. Shale fragments also occur in variable amounts in places.

RASSET SERIES

The Rasset series consists of nearly level to rolling, moderately well drained and well drained soils. These soils occupy large areas on plains and terraces of the North Fork of the Crow River. They formed in sandy outwash under tall prairie grasses and a forest of various kinds of oaks and other deciduous hardwoods. They characteristically contain textural layers believed to have formed in part from weathered, finely divided shale.

Rasset soils are closely associated with the Hubbard and Estherville soils. They are not so excessively drained as the Hubbard soils, which formed in acid sand and lack textural layers. They are deeper than the somewhat excessively drained Estherville soils, which also lack textural layers and are shallow to calcareous outwash gravel and sand.

Representative profile of Rasset loamy sand in a pasture on a slope of 3 percent (NE¼NW¼ sec. 29, T. 119 N., R. 25 W.):

Ap—0 to 9 inches, black (10YR 2/1) loamy sand; massive; very friable; slightly acid; abrupt, smooth boundary.
A2—9 to 10 inches, dark grayish-brown (10YR 4/2) loamy sand; massive; very friable; slightly acid; discontinuous horizon.
B21—10 to 19 inches, very dark grayish-brown (10YR 3/2) to dark-brown (10YR 3/3) sandy loam; weak, medium, subangular blocky structure; very friable; sticky when wet; medium acid; clear, wavy boundary.
B22—19 to 30 inches, dark-brown (10YR 4/3 to 3/3) loamy sand; very weak, medium to coarse, subangular blocky structure; very friable; sticky when wet; common, distinct clay bridges between sand grains; medium acid; abrupt, smooth boundary.
B23—30 to 31 inches, very dark grayish-brown (10YR 3/2) to dark-brown (10YR 3/3) sandy clay loam; weak, medium, subangular blocky structure; friable to firm; medium acid; abrupt, smooth boundary.

B24—31 to 36 inches, dark yellowish-brown (10YR 4/4) loamy sand; very weak, medium to coarse, subangular blocky structure; very friable; medium acid; abrupt, smooth boundary.
B25—36 to 37 inches, dark-brown (10YR 4/3) to dark yellowish-brown (10YR 4/4) sandy clay loam with fine shale fragments; weak, medium, subangular blocky structure; very friable; medium acid; abrupt, smooth boundary.
B31—37 to 43 inches, dark yellowish-brown (10YR 4/4) to yellowish-brown (10YR 5/4) medium sand; single grain; loose; medium acid; abrupt, wavy boundary.
B32—43 to 48 inches, dark-brown (7.5Y 3/4 and 3/2) gravelly loamy sand with finer textured material in small pockets; massive; loose; medium acid; abrupt, wavy boundary.
C—48 to 50 inches, grayish-brown (2.5Y 5/2) to light brownish-gray (2.5Y 6/2) medium sand; single grain; loose; slightly calcareous.

The surface layer generally is loamy sand or sandy loam. The A1 horizon is 7 to 10 inches thick. If present, the A2 horizon is incipient and discontinuous.

The substratum contains dark-brown to dark yellowish-brown layers within a depth of 42 inches. These vary greatly in texture, thickness, and frequency of occurrence. The loamy sand and sandy loam layers are as much as 12 inches in thickness, but the loam to clay loam layers are seldom more than 1 to 2 inches thick and occur less frequently. All of these layers generally contain variable amounts of fine shale fragments, but shale fragments are not always present. In color these layers when moist range from very dark grayish brown (10YR 3/2) to dark brown (10YR 3/3) and dark yellowish brown (10YR 4/3 and 4/4). The underlying material consists of sand and small amounts of gravel.

Rasset soils are neutral to medium acid throughout the profile. The underlying material is slightly acid to medium acid, but it is calcareous within a depth of 48 to 72 inches. Free lime carbonates are at a depth of 36 inches in a few places. Though drainage ranges from moderately well drained to well drained, Rasset soils generally are well drained. Nearly level areas, or areas close to streams, have a fairly high water table.

SALIDA SERIES

Soils of the Salida series are very shallow, gently undulating to very steep, and excessively drained. These soils are on hilly slopes in areas of stream and glacial outwash. They formed in material from loose, calcareous, brownish sand and gravel. The native vegetation was prairie grasses.

Salida soils are closely associated with the Estherville soils. Their solum is thinner and coarser textured, however, and drainage is more excessive.

Representative profile of Salida gravelly sandy loam in a cultivated field on a slope of 3 percent (SE¼NW¼ sec. 35, T. 118 N., R. 26 W.):

Ap—0 to 6 inches, very dark gray (10YR 3/1) gravelly sandy loam; single grain; hard when dry; friable; neutral; clear, wavy boundary.
B—6 to 11 inches, very dark grayish-brown to dark-brown (10YR 3/2 to 4/3) gravelly sandy loam; single grain; loose; neutral; clear, irregular boundary.
C—11 to 45 inches, variegated brown (10YR 5/3), yellowish-brown (10YR 5/4 and 5/6), and dark-brown (10YR 4/3), medium and coarse gravel and coarse sand; in places fingers of gravelly loamy sand; single grain; loose; calcareous.

The A horizon generally is gravelly sandy loam, but in a few places it is gravelly loamy sand. The A1 horizon is 4 to 8 inches thick. The B horizon is dark grayish-brown to dark yellowish-brown gravelly sandy loam or gravelly loamy sand or it is fine gravel and coarse sand that includes some fines. It is discontinuous and irregular or wavy and ranges from 1 to 8 inches in thickness. The underlying material is coarse sand and gravel and in places it is cobbly, stony, or bouldery. The A and B horizons range from neutral to medium acid but generally are neutral to slightly acid. The underlying coarse material generally is weakly calcareous to strongly calcareous, but in a few places it is leached of free carbonates and is slightly acid to medium acid to a depth of 36 inches.

SATTRE SERIES, SILTY VARIANT

These variants from the normal Sattre soils are moderately deep, nearly level to gently undulating, well drained, and silty. These soils are underlain by loose, calcareous, grayish-brown sand and gravel at a depth of 24 to 42 inches. They are on outwash plains of the Clearwater River in the northwestern part of the county. The native vegetation was grasses and deciduous hardwoods.

These soils have drainage similar to that of the Fairhaven soils, but unlike those soils, they have a thin A1 horizon, a distinct A2 horizon, and a well-developed B2 horizon. Their drainage also is similar to that of the Lester variants, which formed in very deep, calcareous, silty material. In contrast to the somewhat excessively drained Burnsville soils, Sattre variants are silty, rather than loamy, over calcareous gravel and sand.

Representative profile of Sattre silt loam, silty variant, in a wooded area occupied mostly by ironwood trees, on a slope of 1 percent (SW¼SE¼ sec. 17, T. 121 N., R. 28 W.):

A1—0 to 3 inches, very dark gray (10YR 3/1) silt loam; moderate, very fine and fine, granular structure; very friable when moist, slightly plastic when wet; high content of organic matter; slightly acid.
A2—3 to 8 inches, very dark gray to very dark brown (10YR 3/1 to 2/2), gray (10YR 5/1, dry) silt loam; weak, very fine, subangular blocky structure; very friable when moist, slightly plastic when wet; slightly acid.
B21t—8 to 13 inches, very dark grayish brown (10YR 3/2) to dark grayish-brown (10YR 3/2 to 4/2) heavy silt loam; moderate, very fine, subangular blocky structure; grayish-brown (10YR 5/2, dry) silica coatings; friable when moist, slightly plastic to plastic when wet; medium acid.
B22t—13 to 18 inches, dark-brown (10YR 4/3) and dark grayish-brown (10YR 4/2) heavy silt loam; moderate, very fine, subangular blocky structure; friable when moist, slightly plastic to plastic when wet; medium acid.
B3—18 to 26 inches, yellowish-brown (10YR 5/4) to light olive-brown (2.5Y 5/4) silt loam; weak to moderate, very fine, subangular blocky structure; friable when moist, slightly plastic when wet; medium acid.
IIC1—26 to 30 inches, dark grayish-brown (10YR 4/2) to dark-brown (10YR 4/3) sandy loam; massive; loose when moist, slightly sticky when wet; slightly calcareous.
IIIC2—30 to 40 inches, variegated dark yellowish-brown (10YR 4/4), yellowish-brown (10YR 5/4), and dark-brown (10YR 5/3 and 4/3) fine gravel and coarse sand; single grain; loose when moist; calcareous.

The A horizon generally is silt loam. Most areas have been cleared and cultivated. In the few remaining

wooded areas, the A1 horizon is very dark gray to black and is less than 4 inches thick. The A2 horizon is 3 to 6 inches thick and has weak, very thin, platy structure to weak, very fine, subangular blocky. It is light-gray (10YR 6/1), gray (10YR 5/1), or grayish brown (10YR 5/2) when dry. In cultivated areas the A horizon is very dark brown to very dark grayish brown when moist.

The B2 horizon is brownish heavy silt loam or silty clay loam and has moderate, very fine and fine, subangular blocky structure. Grayish-brown (10YR 5/2, dry) silica coatings are in the upper part of this horizon. Dark-brown (10YR 2/2) to black (10YR 2/1, moist) organic stains coat some of the peds and are in old root channels.

The combined thickness of the A and B horizons ranges from 24 to 42 inches but generally is 24 to 30 inches. These horizons range from slightly acid to medium acid. The coarse underlying material is calcareous, water-sorted sand and gravel. A few stones are on the surface and throughout the profile.

STORDEN SERIES

Soils of the Storden series are deep, gently rolling to hilly, and well drained. They are in the upland, mostly in the southwestern part of the county. These soils formed in grayish, calcareous, friable loam or clay loam glacial till of late Wisconsin age. The vegetation was originally prairie grass, but in most areas deciduous hardwoods encroached.

Storden soils are closely associated with and have drainage similar to that of the Lester soils but are not so well developed. Also, unlike those soils, they lack a B horizon or have only a thin one, and their solum is less than 12 inches deep to calcareous underlying material.

Representative profile of Storden loam in a cultivated field on a slope of 8 percent (NE¼NE¼ sec. 3, T. 118 N., R. 26 W.):

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) loam; cloddy; friable; slightly calcareous; abrupt, smooth boundary.

C—7 to 45 inches, light olive-brown (2.5Y 5/4) light clay loam; grayish-brown (2.5Y 5/2) segregated lime; massive; friable; slightly plastic; a few iron stains, lime pebbles, and shale fragments; calcareous.

Storden soils generally have a surface layer of loam. In places stones and boulders are on the surface and throughout the profile.

TALCOT SERIES

Soils of the Talcot series are moderately deep and are very poorly drained. These soils are in shallow depressions and drainageways in outwash plains and stream terraces. They formed in material from calcareous, grayish gravel and sand. The native vegetation was marsh grasses, reeds, and willows.

Talcot soils are associated with the poorly drained Biscay soils. They are more ponded than those soils and also have a thicker A horizon that is more abruptly and intensively gleyed. Talcot soils are also associated with the well-drained Wadena soils and the somewhat excessively drained Estherville.

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Representative profile of Talcot clay loam in a depression under reed canarygrass and swampweed on a slope of less than 1 percent (NW¼SW¼ sec. 33, T. 121 N., R. 27 W.):

O2—0 to 4 inches, black (10YR 2/1) muck; slightly calcareous; gradual, wavy boundary.

A1—4 to 15 inches, black (N 2/0) light clay loam; massive; slightly plastic and slightly sticky; slightly calcareous; gradual, wavy boundary.

A12—15 to 23 inches, very dark gray (2.5Y 3/0) light clay loam; massive; slightly plastic and slightly sticky; slightly calcareous; gradual, wavy boundary.

B—23 to 31 inches, olive-gray (5Y 5/2) to olive (5Y 5/3) sandy clay loam; a few, fine, faint mottles of light olive brown (2.5Y 5/4); massive; slightly plastic and slightly sticky; slightly calcareous; gradual, wavy boundary.

IIC1—31 to 35 inches, olive-gray (5Y 5/2) to olive (5Y 5/3) loamy fine gravel and coarse sand variegated with light olive brown (2.5Y 5/6) and olive yellow (2.5Y 6/6); a few, fine, prominent mottles of greenish gray (5BG 5/1); single grain; loose; calcareous; clear, wavy boundary.

IIIC2g—35 to 38 inches, greenish-gray (5G 5/1) sandy clay loam; common, medium, prominent mottles of greenish gray (5BG 5/1); massive; nonplastic and slightly sticky; calcareous; clear, wavy boundary.

IVC3g—38 to 40 inches, greenish-gray (5GY 5/1) fine gravel and coarse sand variegated with olive gray (5Y 5/2) and olive (5Y 5/4); single grain; loose; calcareous; clear, wavy boundary.

IVC4g—40 to 43 inches, olive (5Y 5/3) gravelly loamy sand, common, medium, prominent mottles of greenish gray (5G 5/1); massive; very friable; calcareous; clear, wavy boundary.

IVC5g—43 to 48 inches, greenish-gray (5G 5/1) fine gravel and coarse sand variegated with olive gray (5Y 5/2) and olive (5Y 5/4); single grain; loose when moist; calcareous.

In places these soils have as much as 12 inches of muck or peat overlying the A1 horizon. The A1 horizon is silty clay loam or light clay loam that ranges from 10 to 24 inches in thickness. The B horizon generally is loam or clay loam and contains a few thin layers of sandy loam. Depth to gravel and coarse sand is 24 to 42 inches. In places within a depth of 60 inches, a few thin layers of material that ranges from loamy sand and gravel to sandy clay are within this coarse underlying material. The solum and the underlying material are slightly calcareous to moderately calcareous.

TERRIL SERIES

The Terril series consists of deep, moderately well drained soils formed in recent colluvium. They are in the upland at the base of steep slopes or are in drainageways. The native vegetation was grasses and various kinds of hardwoods.

Terril soils are closely associated with the well-drained Lester and Hayden soils and the poorly drained Cordova and Webster.

Representative profile of Terril loam in a cultivated field on a slope of 6 percent (NW¼SE¼ sec. 15, T. 119 N., R. 28 W.):

Ap—0 to 8 inches, black (10YR 2/1) loam; cloddy; friable; neutral.

A12—8 to 15 inches, black (10YR 2/1) loam; weak, very fine, subangular blocky structure; friable; neutral.

A13—15 to 28 inches, black (10YR 2/0) loam; weak, very fine, subangular blocky structure; friable; neutral.

A14—28 to 38 inches, black (10YR 2/1) to very dark brown (10YR 2/2) heavy loam; weak, fine and very fine, subangular blocky structure; friable; neutral.
AC1—38 to 45 inches, very dark brown (10YR 2/2) and very dark gray (10YR 3/1) heavy loam; weak, fine and very fine, subangular blocky structure; friable; slightly acid.
AC2—45 to 52 inches, very dark brown (10YR 2/2) and very dark gray (10YR 3/1) loam; weak, fine and very fine, subangular blocky structure; friable; medium acid.

The surface layer is loam in most places, but it is sandy loam and clay loam in some places. In most places from 12 to 30 inches of recent overwash is on the surface. The B horizon ranges from loam to clay loam and has weak to moderate blocky structure. The surface soil is neutral to slightly acid, and the B horizon is neutral to medium acid.

WADENA SERIES

Soils of the Wadena series are moderately deep, medium textured, nearly level to rolling, and well drained. They formed under prairie grasses over loose, calcareous, grayish-brown sand and gravel. These soils occupy large areas on outwash plains and terraces of the Mississippi and Crow Rivers.

Wadena soils are closely associated with the somewhat excessively drained Estherville soils but are deeper to sand and gravel. They are similar to the somewhat excessively drained Hubbard soils, but their solum is finer textured and thicker and is less deeply leached. Their drainage is similar to that of the Fairhaven soils, but they have less silt throughout the solum.

Representative profile of Wadena loam in a cultivated field on a slope of 1 percent (SW¼NE¼ sec. 13, T. 121 N., R. 25 W.):

A1p—0 to 7 inches, black (10YR 2/1) loam; cloddy; friable; slightly acid; clear, smooth boundary.
A1—7 to 10 inches, black (10YR 2/1) loam; weak, very fine, subangular blocky structure; friable; slightly acid; clear, smooth boundary.
A3—10 to 13 inches, very dark grayish-brown (10YR 3/2) to very dark brown (10YR 2/2) loam; weak, very fine, subangular blocky structure; friable; slightly acid; clear, smooth boundary.
B21—13 to 18 inches, dark-brown (10YR 3/3) to dark yellowish-brown (10YR 3/4) loam; weak, very fine and fine, subangular blocky structure; friable; slightly acid; clear, smooth boundary.
B22—18 to 21 inches, dark-brown (10YR 4/3) to dark yellowish-brown (10YR 3/4) loam; weak, very fine and fine, subangular blocky structure; friable; medium acid; clear, smooth boundary.
B3—21 to 25 inches, dark yellowish-brown (10YR 3/4) to dark-brown (7.5Y 4/4) loam; massive; friable; medium acid; clear, smooth boundary.
IIB3—25 to 36 inches, dark grayish-brown (2.5Y 4/2) coarse sand and some fine gravel; single grain; coherent lumps break under very slight pressure; slightly acid; clear, smooth boundary; clay bridges are between the sand grains.
C1—36 to 40 inches, dark grayish-brown (2.5Y 4/2 and 10YR 4/2) fine and medium, shaly gravel and coarse sand; single grain; loose; neutral; clear, smooth boundary.
C2—40 to 49 inches, variegated brown (10YR 5/3), grayish-brown (10YR 5/2), dark grayish-brown (10YR 4/2), dark-brown (10YR 4/3), and light brownish-gray (10YR 6/2) coarse sand; a few, fine and medium lime pebbles; single grain; loose; calcareous.

The surface layer generally is loam. In texture the B2 horizon generally is loam or light clay loam. Thickness of the solum ranges from 24 to 30 inches in most places. The A horizon is neutral to slightly acid, and the B horizon is slightly acid to medium acid.

WATSEKA SERIES

Soils of the Watseka series are somewhat poorly drained and coarse textured. These soils are in drainageways and shallow depressions in outwash plains and terraces. They formed under grasses in loose, noncalcareous sand and gravel of late Wisconsin age.

Watseka soils are mostly in drainageways within areas of excessively drained Hubbard loamy sands. They are similar to the Duelm soils in drainage, but those soils have a solum of sandy loam.

Representative profile of Watseka loamy sand in a shallow depression in a cultivated field on a slope of less than 1 percent (NE¼SE¼ sec. 27, T. 121 N., R. 23 W.):

A1p—0 to 12 inches, very dark gray (10YR 3/1) loamy sand; weak, very fine, granular structure; very friable to loose; neutral.
B—12 to 16 inches, dark grayish-brown (2.5Y 4/2) weak loamy sand; single grain; very friable to loose; neutral.
C1—16 to 19 inches, dark grayish-brown (2.5Y 4/2) sand; a few, fine, distinct mottles of dark yellowish brown (10YR 4/4); single grain; loose; neutral.
C2—19 to 30 inches, dark grayish-brown (2.5Y 4/2) to very dark grayish-brown (2.5Y 3/2) sand; single grain; loose; slightly acid.
C3—30 to 36 inches, dark grayish-brown (2.5Y 4/2), light olive-brown (2.5Y 5/6), and light yellowish-brown (2.5Y 6/4) sand that contains a small amount of fine gravel; single grain; loose; a few reddish-orange iron stains; slightly acid.
C4—36 to 48 inches, dark grayish-brown (2.5Y 4/2), light olive-brown (2.5Y 5/6), and light yellowish-brown (2.5Y 6/4) medium and coarse sand that contains a small amount of fine gravel; slightly acid.

The surface layer generally is loamy sand. In thickness the A horizon ranges from 10 to 18 inches. The loamy sand part of the solum generally is less than 24 inches thick. The substratum is mainly coarse and medium sand. Variable mottles of olive brown, olive, or dark yellowish brown generally are within a depth of 18 inches. Watseka soils range from neutral to medium acid, but they generally are neutral to slightly acid to a depth of more than 48 inches.

WEBSTER SERIES

In the Webster series are deep, poorly drained soils. These soils occupy large areas on nearly level flats and in shallow drainageways in the upland. They formed in friable, calcareous, grayish loam or clay loam glacial till of late Wisconsin age. The native vegetation was tall prairie grass and marsh bunchgrass.

Webster soils are closely associated with the Cordova soils and have similar drainage, but their B2 horizon lacks the marked increase in clay content and the structural development common in these soils. They also lack an indistinct A2 horizon, which is common in Cordova soils. Webster soils are also closely associated with the moderately well drained Le Sueur soils and the well drained Lester. They are similar to the poorly drained Canisteo soils, but those soils are calcareous throughout.

Representative profile of Webster silty clay loam in a meadow of clover and grass on a slope of 1 percent (NW¼NW¼ sec. 27, T. 118 N., R. 26 W.):

A1p—0 to 8 inches, black (10YR 2/1) silty clay loam; moderate, very fine, subangular blocky structure; friable when moist, plastic and sticky when wet; neutral; clear, smooth boundary.

A3—8 to 13 inches, very dark gray (10YR 3/1) silty clay loam; contains irregular tongues of black (10YR 2/1) material from layer above; weak, very fine, subangular blocky structure; friable when moist, plastic and sticky when wet; neutral; clear, irregular boundary.

B21g—13 to 18 inches, dark grayish-brown (2.5Y 4/2) clay loam; a few, fine, faint mottles of olive (5Y 5/3 to 5/4); contains irregular tongues of very dark gray (10YR 3/1) material from layer above; weak, very fine, subangular blocky structure; friable when moist, plastic and sticky when wet; a few orange and reddish iron stains; a few small shale fragments neutral; clear, irregular boundary.

B22g—18 to 24 inches, olive-gray (5Y 4/2) clay loam; common, fine, distinct mottles of olive (5Y 5/3 to 5/4); contains irregular tongues of very dark gray (5Y 3/1) material from layer above; weak, very fine, subangular blocky structure; friable when moist, slightly plastic to plastic and slightly sticky when wet; a few orange and reddish iron stains; a few small shale fragments; neutral; clear, wavy boundary.

Cg—24 to 48 inches, olive-gray (5Y 5/2) and olive (5Y 5/3) loam; common, fine, distinct mottles of olive (5Y 5/4); weak, very fine, subangular blocky structure; friable when moist, slightly plastic and slightly sticky when wet; abundant orange and reddish iron stains; many lime pebbles and a few shale fragments; calcareous.

The A horizon generally is silty clay loam, but it is silt loam in small areas. Its thickness ranges from 10 to 18 inches but generally is 12 to 14 inches. The B horizon is silty clay loam and clay loam and lacks a marked increase in clay content. It has very weak to no structural development, but characteristically is olive gray in color and mottled to varying degrees. The Webster soils are neutral to slightly acid in the A and B horizons. Depth to free lime carbonates ranges from 18 to 30 inches.

WEBSTER SERIES, SILTY VARIANT

The variants from the normal Webster series are deep and poorly drained. These soils are in shallow depressions and drainageways in areas of lacustrine silt, mostly in the lake region in the northwestern part of the county. They formed in calcareous, silty sediments laid down by water. The native vegetation was grass.

These soils are associated with the well-drained variants from the Lester series. They are similar to the Webster and Marna soils in drainage but are more silty throughout than the Webster soils and are coarser textured throughout than the Marna soils, both of which are underlain by glacial till.

Representative profile of Webster silty clay loam, silty variant, in a cultivated drainageway on a slope of 1 percent (NE¼NE¼ sec. 29, T. 121 N., R. 27 W.):

A1p—0 to 8 inches, black (10YR 2/1) light silty clay loam; cloddy; friable when moist, slightly plastic when wet; neutral; gradual, smooth boundary.

A1—8 to 13 inches, black (10YR 2/1) light silty clay loam; moderate, very fine, subangular blocky structure; friable when moist, slightly plastic when wet; neutral; gradual, wavy boundary.

A3—13 to 16 inches, very dark gray (10YR 3/1) to black (10YR 2/1) light silty clay loam; moderate, very fine, subangular blocky structure; friable when moist, slightly plastic when wet; calcareous; gradual, wavy boundary.

B—16 to 21 inches, very dark gray (10YR 3/1) and gray (10YR 4/1) light silty clay loam; weak, very fine, subangular blocky structure; friable when moist, slightly plastic and slightly sticky when wet; strongly calcareous; clear, wavy boundary.

Cg1—21 to 26 inches, grayish-brown (2.5Y 5/2) and light brownish-gray (2.5Y 6/2) silt loam or light silty clay loam; varved; friable when moist, slightly plastic to plastic and slightly sticky when wet; strongly calcareous; gradual, wavy boundary.

Cg2—26 to 41 inches, olive-gray (5Y 5/2) heavy silt loam; many, fine, distinct mottles of olive (5Y 5/3 and 5/4); varved; friable when moist, slightly plastic and slightly sticky when wet; prominent reddish-orange iron stains; strongly calcareous; clear, wavy boundary.

Cg3—41 to 48 inches, olive-gray (5Y 5/2) very fine sand; many, fine, distinct mottles of olive (5Y 5/3 to 5/4 and 5/6); single grain; slightly coherent; calcareous; clear, wavy boundary.

Cg4—48 to 50 inches, olive-gray (5Y 5/2) and light olive-gray (5Y 6/2) silt loam; varved; friable when moist, slightly plastic and slightly sticky when wet; many reddish and orange iron stains; segregated lime nodules; calcareous; clear, wavy boundary.

Cg5—50 to 55 inches, olive-gray (5Y 5/2) very fine sand; many, fine, distinct mottles of olive (5Y 5/3 and 5/4); single grain; slightly coherent; many reddish and orange iron stains; segregated lime nodules; calcareous.

The A horizon generally is silty clay loam, but in some areas it is silt loam. It ranges from 12 to 18 inches in thickness. The B horizon is silty clay loam or silt loam and has weak to moderate blocky structure. The C horizon is silt loam or silty clay loam and generally is varved. In places layers of very fine sand or silt are in the underlying material. In reaction the A1 horizon is neutral to mildly alkaline. The B and C horizons are calcareous. These soils generally are free of pebbles and stones.

Laboratory Analyses

Table 10 lists physical and chemical characteristics of some selected soils in Wright County. One profile of two soil types were sampled for analysis. The profiles of these soils are described in detail in the section "Classification and Morphology of Soils."

The data in table 10 show facts about the parent materials of the soils and the climate under which they formed. They are used by soil scientists in classifying the soils. They are also helpful in estimating responses of the soils to use and management.

One sample was taken of each of the two soil types studied. The samples were obtained from soils in carefully selected pits dug through the solum and into the parent material. Samples were collected from each horizon that could be recognized, and they are considered representative of soil material made up of particles less than three-quarter inch in diameter.

Methods of the Soil Survey Laboratory, Lincoln, Nebr., were used to obtain most of the data shown in table 10. In all the laboratory procedures used, air-dry samples were crushed with a rolling pin so that the soil material would pass through a 2-millimeter, square-hole sieve. Care was taken to avoid fragmenting the nonsoil material. The percentage of material retained on the sieve is reported in the column "Coarse fragments

TABLE 10.—*Physical and chemical*

[Dashes indicate determination was made,

Soil name, sample number, and horizon	Depth	Particle-size distribution								pH
		Very coarse sand (2 to 1 mm.)	Coarse sand (1 to 0.5 mm.)	Medium sand (0.5 to 0.25 mm.)	Fine sand (0.25 to 0.10 mm.)	Very fine sand (0.10 to 0.05 mm.)	Silt (0.05 to 0.002 mm.)	Clay (less than 0.002 mm.)	Coarse fragments (greater than 2 mm.)	
Hayden loam: S60 Minn., 86–2 (1–8).	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	
A1	0 to 2	2.5	5.3	6.8	18.8	10.8	39.4	16.4	(2)	6.4
A2	2 to 7	3.7	5.9	6.9	19.4	11.8	39.1	13.2	(2)	6.8
A2 and B	7 to 10	3.2	5.8	7.0	19.0	11.8	31.5	21.7	(2)	6.7
B21	10 to 15	3.6	7.1	7.2	17.1	10.4	24.6	30.0	(2)	6.5
B22	15 to 22	4.2	7.7	7.2	14.3	8.6	25.1	32.9	(2)	6.4
B23	22 to 32	5.7	8.8	8.0	16.2	9.7	22.2	29.4	9	6.2
C1	32 to 39	4.8	8.8	8.1	18.1	11.1	30.3	18.8	6	7.9
C2	39 to 55	3.9	6.6	7.3	19.9	12.2	31.5	18.6	(2)	8.0
Hubbard loamy sand: S60 Minn., 86–3 (1–6).										
Ap	0 to 9	2.8	25.7	36.9	21.0	1.5	7.5	4.6	(2)	5.2
AC	9 to 16	2.0	20.9	37.5	24.4	1.6	8.1	5.5	(2)	5.4
C1	16 to 24	1.8	23.1	40.2	24.2	1.4	5.5	3.8	----------	5.5
C2	24 to 31	3.7	35.3	40.0	16.2	.7	2.3	1.8	(2)	5.8
C3	31 to 42	4.0	22.7	41.3	27.9	.6	1.9	1.6	(2)	6.0
C4	42 to 62	7.9	25.3	34.2	29.8	.7	.9	1.2	3	6.2

[1] Laboratory determinations by Soil Survey Laboratory, Lincoln, Nebr.; laboratory numbers are 13712 through 13719 for Hayden and 13720 through 13725 for Hubbard.

[2] Trace; determination made but amount determined was less than the minimum value considered reportable.

(greater than 2 mm.)." Unless otherwise stated all laboratory analyses were made by using the part of the sample consisting of soil material less than 2 millimeters in diameter and that was ovendry, and results are reported on that basis.

Analyses of particle-size distribution was made by the pipette method (*7*, *8*, *9*). The pH was determined by glass electrode, using soil and water in a ratio of 1:1 (*10*, *12*).

The content of organic carbon was determined by using a modification of the Walkley-Black method (*10*). Concentrated hydrochloric acid was added to the soil samples, and the volume of carbon-dioxide emitted was measured to determine the calcium carbonate equivalent. The cation exchange capacity was determined by direct distillation of absorbed ammonia (*10*).

Extractable calcium, magnesium, sodium, and potassium were determined by extraction with neutral, normal ammonium acetate (*10*). Determinations of extractable hydrogen were made by the triethanolamine method (*10*).

General Nature of the County

This section gives facts about the climate, physiography, and streams and lakes of the county. Information is also given about the settlement and development and about the agriculture. Statistics used in the discussion of the agriculture are from reports of the U.S. Bureau of the Census.

Climate [6]

Wright County has a continental climate, typical of that near the center of the great land mass that makes up the North American Continent. Winters are cold. Summers are warm and pleasant. Interaction between cool air from the northwest and warm, moist air from the southwest causes marked daily and seasonal changes in temperature and precipitation. This changeable weather gives the county a stimulating and invigorating climate. Temperature and precipitation data for the county are given in table 11.

Cold air from Canada and the Arctic causes frequent sudden lowering of the temperature in winter. Freezing temperatures are zero or lower on more than 40 days in an average winter. The average temperature for the months of June, July, and August is 70.3° F. Days when the temperature is 90° or more generally are less than 12 in a year. Hot, humid weather generally does not last long, because warm, moist air from the south seldom pushes so far north as Wright County.

[6] By DONALD A. HAINES, State climatologist, U.S. Weather Bureau.

characteristics for two selected soils [1]

but a detectable value was not obtained]

Organic matter				Cation exchange capacity (NH_4OAc)	Extractable cations (milliequivalents per 100 grams of soil)					Base saturation (NH_4OAc)	Calcium magnesium ratio
Organic carbon	Nitrogen	Carbon-nitrogen ratio	Calcium carbonate equivalent		Calcium	Magnesium	Hydrogen	Sodium	Potassium		
Percent	*Percent*		*Percent*	*Meq./100 gms.*							
5. 59	0. 488	11	0. 1	27. 5	(3)	2. 4	6. 6	0. 1	0. 3	101	(3)
1. 01	. 085	12	----------	11. 2	10. 0	. 6	2. 7	. 1	. 2	96	(3)
. 48	. 055	9	----------	15. 2	12. 0	2. 8	2. 5	. 1	. 3	100	4. 3
. 47	. 049	10	----------	21. 3	16. 1	5. 3	2. 8	. 1	. 4	103	3. 0
. 34	. 040	8	----------	22. 1	15. 7	6. 3	3. 3	. 1	. 4	102	2. 5
. 24	. 037	(3)	----------	21. 0	14. 1	6. 1	4. 3	. 1	. 4	98	2. 3
. 20	----------	----------	11. 2	13. 5	(3)	4. 2	. 1	. 1	. 2	195	(3)
. 14	----------	----------	16. 6	13. 2	(3)	3. 4	. 1	. 1	. 2	216	(3)
. 58	. 060	10	----------	5. 0	1. 9	. 2	5. 7	. 1	. 1	42	(3)
. 42	. 046	9	----------	4. 7	2. 5	. 1	4. 0	. 1	. 1	53	----------
. 18	. 026	(3)	----------	2. 9	1. 4	. 2	2. 0	. 1	. 1	55	(3)
. 05	----------	----------	----------	1. 8	1. 1	. 2	1. 5	. 1	. 1	72	(3)
. 04	----------	----------	----------	1. 7	1. 2	. 1	. 7	. 1	. 1	70	----------
. 01	----------	----------	----------	1. 4	. 9	. 1	. 5	----------	----------	64	----------

[3] Values determined but were too low for meaningful interpretation or considered not representative.

TABLE 11.—*Temperature and precipitation, Wright County, Minnesota*

[Data from Maple Plain, Hennepin County, Minn.]

Month	Temperature					Precipitation				
	Average daily maximum	Average daily minimum	Monthly average	Two years in 10 will have at least 4 days with—		Average monthly total	One year in 10 will have—		Days with snow cover 1.0 inch or more	Average depth of snow on days with snow cover
				Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Less than—	More than—		
	° *F.*	° *F.*	° *F.*	° *F.*	° *F.*	*Inches*	*Inches*	*Inches*	*Number*	*Inches*
January	22	3	12	40	−20	0. 9	0. 3	2. 0	24	5
February	26	6	16	48	−14	1. 0	. 2	1. 8	22	6
March	37	19	28	56	−3	1. 8	. 8	3. 2	13	5
April	55	34	45	76	20	2. 3	. 9	3. 4	1	3
May	69	46	57	85	33	3. 8	1. 5	5. 9	(1)	----------
June	78	57	68	94	44	4. 8	2. 4	8. 2	0	----------
July	84	61	73	97	51	3. 7	1. 3	6. 2	0	----------
August	81	59	70	94	48	3. 8	1. 9	5. 7	0	----------
September	71	50	60	88	36	2. 6	. 7	5. 1	(1)	----------
October	60	39	49	76	25	1. 6	. 3	2. 8	(1)	----------
November	39	23	31	58	2	1. 7	. 5	3. 0	6	3
December	27	10	18	42	−11	1. 0	. 2	1. 8	18	5
Year	54	34	44	[2] 112	[3] −37	29. 0	22. 1	33. 8	84	5

[1] Less than 0.5 day. [2] Highest maximum recorded. [3] Lowest minimum recorded.

TABLE 12.—*Probability of freezing temperatures in spring and in fall, Wright County, Minn.*

[Data from records kept at Maple Plain, Hennepin County, Minn.]

Probability	Dates for given probability and temperature				
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
1 year in 10 later than	April 10	April 19	April 28	May 9	May 22
2 years in 10 later than	April 5	April 14	April 24	May 5	May 17
5 years in 10 later than	March 26	April 4	April 16	April 25	May 7
Fall:					
1 year in 10 earlier than	October 27	October 18	October 9	September 25	September 9
2 years in 10 earlier than	November 1	October 23	October 14	October 2	September 26
5 years in 10 earlier than	November 10	November 2	October 26	October 14	October 5

Measurable snowfall of 1 inch or more generally comes in November. The last measurable snow in spring falls early in April as often as 1 year in 2. Strong winds are rare in winter, and severe blizzards and excessive drifting of snow therefore seldom occur. The temperature generally remains below freezing in the afternoon during the winter months, and alternate thawing and freezing are infrequent.

The growing season is favorable for the crops grown in the county to mature without much damage from frost. The probabilities of certain temperatures occurring in spring and in fall are shown in table 12 (*2*, *3*). This table shows, for example, that 5 years out of 10, or 50 percent of the time, a temperature of 32° or lower can be expected to occur later than May 7 in spring and earlier than October 5 in fall.

Precipitation is ample for farm and garden crops grown in the county, and it generally is well distributed throughout the growing season. About 56 percent of the precipitation falls during the months of May through August, mainly as the result of thunderstorms (*4*).

Tornadoes, freezing rain, and other damaging storms are not numerous, though these have been troublesome at times. The county is along the northern edge of the region of maximum tornado frequency, but only six tornadoes have occurred in the county in the period from 1916 through 1964. Ice storms that cause extensive damage to trees and overhead wires average less than one a year. Damage from heavy rain, wind, and hail in connection with thunderstorms occurs each year.

Records of humidity, of clear and cloudy days, and of wind direction are not available for Wright County, but data from the weather station at St. Cloud, 12 miles northwest of Wright County, are representative of conditions in this county. These records show that relative humidity at noon ranges from 55 percent in summer to as much as 72 percent in winter. During a typical year there are about 97 days that are clear, 105 days that are partly cloudy, and 163 days that are cloudy. The prevailing direction of the wind is from the north from December through April. It is from a southerly direction the other months.

Physiography

Wright County is in the Central Lowland province of the Western Young Drift section of the Interior Plains (*6*). Depth of the drift over bedrock ranges from 100 to more than 400 feet, and it is thickest in the central and southwestern parts of the county (*20*). The areas are nearly level to very steep. Most areas in the south-central part of the county are on a strongly rolling to hilly terminal moraine or are on a gently undulating ground moraine. The only large, nearly level areas in the county are on outwash plains along the Clearwater and Mississippi Rivers.

Elevation ranges from about 1,100 feet to 843 feet. The highest areas are in the southwestern part of the county and on the tops of prominent hills near Clearwater and Monticello, and the lowest area is at Dayton on the shore of the Mississippi River.

Streams and Lakes

All streams in Wright County eventually empty into the Mississippi River, which borders the northern part of the county from Clearwater to Dayton. The Clearwater River, along the last 15 miles of its course, bounds the county on the northwest and enters the Mississippi River at Clearwater.

The major streams flowing through Wright County are the North and South Forks of the Crow River. The North Fork enters the western side of the county near the middle and meanders southeastward. The South Fork enters the county in the southeastern corner and flows northward to unite with the North Fork near Rockford. From this juncture the Crow River flows northeastward and forms the border of the county as far as Dayton, where it empties into the Mississippi River.

The main tributaries of the Crow River are Sucker Creek, in the southwestern part of the county, and Twelvemile Creek, southwest of Little Waverly Lake. Silver Creek, also an important stream, drains northward from Lake Mary through Silver Creek Township to enter the Mississippi River.

Lakes are numerous in the county. More than 90 of them are a half mile long or longer. Pelican Lake, in the northeastern section, is the largest lake completely within the county. Clearwater Lake, which also extends into Stearns County, has a shoreline of 36 miles. In addition, many lakelets, marshes, sloughs, and potholes occur throughout the upland.

Settlement and Development

Wright County was organized by act of the Territorial Legislature in 1855, though settlement began soon after treaties with the Indians were signed in 1851. The county was named for Silas Wright, a statesman from New York and friend of a member of the county petitioning committee (*5*).

The first settlers found thick forests of elm, basswood, oak, and other hardwoods in the county and a few open tracts of prairie. Game was plentiful in the forest, and fish and waterfowl were abundant in the many lakes and streams. The first settlement was at Monticello, which was in a prairie opening and along the Mississippi River. Monticello was the first county seat, but later Buffalo, which was more centrally located, became the county seat. The settlers came from many parts of the world. Each nationality settled in a specific area, and today many communities are still made up mainly of people of one distinct nationality.

Farming became the chief occupation after most of the timber was cleared from the county. Wheat and other small grains were the chief crops until the early 1900's, when dairy farming became the main enterprise. Dairying continues to be the main enterprise, but many farmers also grow grain as a cash crop.

U.S. Highway No. 12 passes through the southern part of the county from east to west, and State Highway No. 152 runs in a northwesterly direction through the northern part. Other State and county roads serve every town or village, and nearly every farm is also served by county and township roads.

Two lines of the Great Northern Railway are in the county. One crosses the northern part of the county through Albertville, Monticello, Hasty, and Clearwater, and the other passes through the southern part of the county through Delano, Montrose, Waverly, Howard Lake, and Cokato. The Minneapolis, St. Paul and Sault Ste. Marie Railroad Company, known as the Soo Line, crosses the central part of the county in a northwesterly direction through Rockford, Buffalo, Maple Lake, and South Haven.

The eastern third of Wright County is a part of the Minneapolis-St. Paul milkshed, and other areas are served by creameries in the county. Milk is picked up daily. Trucks take livestock to market in South St. Paul, and nearly every town has a small grain elevator. A large plant for processing eggs is in Buffalo, and two factories for canning sweet corn are in Cokato.

Other industries in the county provide employment for many. Among these are granite works at Delano and Howard Lake, a small boat factory in Annandale, a furniture factory in Cokato, and two factories that manufacture wood products in Buffalo.

Wright County has more than 100 lakes suitable for fishing, swimming, and boating. Many streams also are available for these purposes. Vacation lodges and resorts provide service for many who come to the county for rest and relaxation.

Consolidated schools and other schools provide elementary and high school education throughout the county. Churches of many denominations are in the county, mostly in the towns and villages. Most farms in the county have electrical and telephone service, and mail delivery is available throughout the county.

Agriculture

Agriculture has always been important in the county. The early farmers used most of what they produced because few markets were available. Later wheat was the main crop, but epidemics of rust reduced the acreage greatly by 1939. Dairy farming is now the chief enterprise, though farms on which grain is grown as a cash crop are increasing.

In 1964 there were 2,795 farms in the county, and their average size was 139.7 acres. The total land in farms was 390,432 acres, or 90.9 percent of the land area in the county. Following is a listing of farmland by use and the acreage used for each purpose.

	Acres
Cropland, total	253,825
Harvested	215,753
Pastured	9,635
Not harvested or pastured	28,437
Woodland, total	57,777
Pastured	45,743
Not pastured	12,034
Other pasture (not cropland and not woodland)	41,218
Improved pasture	3,886
Irrigated land in farms	381

Nearly 50 percent of income from farm products came from the sale of dairy products in 1964. About 16 percent came from the sale of field crops, mainly cash grain, and 29 percent from livestock and livestock products other than dairy. Sale of poultry products, vegetables, fruits and nuts, and wood products and horticultural specialties accounted for the rest.

The proportion of farms worked by tenants has decreased from 10 percent in 1959 to 7.8 percent in 1964. In 1964, 63.1 percent of the farms were operated by owners and 28.9 percent by part owners. Two farms were operated by managers.

Most farms in the county have mechanical and power equipment, and nearly every farm has at least one tractor. Modern combines, cornpickers, and hay balers are used on many farms. Farmers who do not own such machines hire operators and machinery to do the necessary work.

Crops.—Corn, oats, alfalfa, and soybeans are the chief crops grown. Wheat, barley, and rye are minor crops, though large acreages of these were once grown. Alfalfa and red clover are grown for seed on a few farms, and potatoes and garden vegetables are grown on some of the

farms. The acreage of the main crops grown in 1964 are shown in the following.

Crop:	*Acres*
Corn for all purposes	88,330
Small grains harvested:	
Oats	32,818
Wheat	3,223
Soybeans	25,266
All hay	64,995

In 1964 most of the corn grown was harvested for grain, and most of the soybeans were harvested for beans. Spring wheat accounted for more than 65 percent of the acreage in wheat. The acreage in hay crops has decreased somewhat, but the proportion of alfalfa hay has increased. Alfalfa hay made up more than 84 percent of the acreage in hay. The rest of the acreage was mostly in small grains and in clover, timothy, and mixtures of clover and grasses, but considerable wild hay also was cut. In addition some grasses, alfalfa, and small grains were cut for silage.

Livestock.—The number of livestock and poultry in the county has fluctuated somewhat throughout the years. Dairy cattle are the chief livestock, though the number of milk cows has decreased slightly. The Holstein, the Guernsey, and the Jersey are the most important breeds of dairy cattle in the county. In 1964 there were 37,432 milk cows in the county. Hogs and pigs numbered 36,612 in 1964, about half the number of those in the county in 1959. The number of sheep and lambs decreased from 6,040 in 1959 to 2,724 in 1964. Poultry numbered 428,857 in 1964, a slight decrease in number from 1959.

Glossary

[Definitions are mostly from Soils and Men (*14*), the Soil Survey Manual (*15*), and Soil (*16*)]

Acidity. See Reaction.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available moisture capacity (also termed available water capacity). The capacity of a soil to hold water in a form available to plants. Amount of moisture held in soil between field capacity, or about one-third atmosphere of tension, and the wilting coefficient, or about 15 atmospheres of tension.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay loam. Soil material that is 28 to 40 percent clay and 20 to 45 percent sand.

Colluvium. Mixed deposits of soil material and rock fragments at the base of fairly steep slopes. The deposits have accumulated as the result of soil creep, slides, or local wash.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent; will not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Deep soil. In this county a soil more than 42 inches deep to rock or other strongly contrasting material. Also, a soil with a deep, black surface layer; a soil more than about 42 inches deep to the parent material or to other unconsolidated rock material not modified by soil-forming processes; or a soil in which the total depth of unconsolidated material, whether true soil or not, is 42 inches or more.

Drainage, soil. The rapidity and extent of the removal of water from the soil by runoff, by flow through the soil to underground spaces, or by a combination of both processes.

Drift (geology). Material of any sort deposited by geologic processes in one place after having been removed from another. Glacial drift consists of earth, sand, gravel, and boulders deposited by glaciers and by the streams and lakes associated with them. It includes *glacial till*, which is not stratified, and *glacial outwash*, which is stratified.

Erosion. The wearing away of the land surface by wind, running water, and other geological agents.

Gleyed soil. A soil in which waterlogging and lack of oxygen have caused the materials in one or more horizons to be neutral gray in color. The term "gleyed" is applied to soil horizons with yellow and gray mottling caused by intermittent waterlogging.

Graded terrace. A terrace constructed at a slight angle to the contour. See Level terrace.

Horizon, soil. A layer of soil, approximately parallel to the soil surface, that has distinct characteristics produced by soil-forming processes.

Internal drainage. The downward movement of water through the soil profile. The rate of movement is determined by the texture, structure, and other characteristics of the soil profile and underlying layers, and by the height of the water table, either permanent or perched. Relative terms for expressing internal drainage are *none, very slow, slow, medium, rapid,* and *very rapid.*

Level terrace. A terrace that follows the absolute contour, as contrasted with a graded terrace. Used only on permeable soils where conservation of moisture for crops is particularly important or where outlet channels are not practical.

Loam. The textural class name for soils that contain a moderate amount of sand, silt, and clay. Loam soils are 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. See also Texture, soil.

Microrelief. Minor surface configurations of the land.

Mineral soil. Soil composed mainly of inorganic (mineral) material and low in content of organic material. Its bulk density is greater than that of organic soil

Modal soil. A soil in a given category, as a soil type or series, that possesses properties typical of the category and that displays these to the degree usually observed.

Moderately deep soil. In this county a soil that has 24 to 42 inches of moderately coarse or finer textured material over bedrock, sand, or gravel.

Morphology, soil. The makeup of the soil, including the texture, structure, consistence, color, and other physical, mineralogical, and biological properties of the various horizons of the soil profile.

Muck. An organic soil consisting of fairly well decomposed organic material that is relatively high in mineral content, finely divided, and dark in color.

Natural drainage. Refers to those conditions that existed during the development of the soil, as opposed to altered drainage. Drainage is generally altered by artificial means or by irrigation but may be altered by sudden deepening of channels or sudden blocking of drainage outlets. The following relative terms are used to express natural drainage: *Excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained,* and *very poorly drained.*

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in elaboration of its food and tissues.

Organic soil. A general term applied to a soil or to a soil horizon that consists primarily of organic matter, such as peat soils, muck soils, and peaty soil layers. In chemistry, organic refers to the compounds of carbon.

Outwash, glacial (geology). See Drift, glacial.

Parent material (soil). The horizon of weathered rock or partly weathered soil material from which soil has formed; horizon C in the soil profile.

Peat. Unconsolidated soil material, largely undecomposed organic matter, that has accumulated where there has been excessive moisture.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability, soil. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

pH value. A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value alkalinity; and a lower value, acidity.

Plow planting. See Wheel-track planting.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. The degrees of acidity or alkalinity are expressed in words as follows:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Relief. The elevations or inequalities of a land surface, considered collectively.

Runoff. The amount of water removed by flow over the surface of the soil. The amount and rapidity of runoff are affected by such factors as texture, structure, and porosity of the surface soil; the plant cover; the prevailing climate; and the slope. The degree of runoff is expressed by the terms, *very rapid, medium, slow, very slow,* and *ponded.*

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Sandy clay. Soil material that is 35 percent or more clay, and 45 percent or more sand.

Sandy clay loam. Soil material that is 20 to 35 percent clay, less than 28 percent silt, and 45 percent or more sand.

Sandy loam. Soil material that is 50 percent sand and less than 20 percent clay

Series, soil. A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the profile.

Shallow soil. In this county a soil that has 12 to 24 inches of moderately coarse or medium textured material over bedrock, sand, or gravel.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeters) to the lower limit of very fine sand (0.05 millimeters). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Silt loam. Soil material that is 50 percent or more silt and 12 to 27 percent clay; or 50 to 80 percent silt and less than 12 percent clay.

Silty clay. Soil material that is 40 percent or more clay and 40 percent or more silt.

Silty clay loam. Soil material that is 27 to 40 percent clay and less than 20 percent sand.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting upon parent material, as conditioned by relief, over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Stratified. Composed of, or arranged in, strata, or layers, such as "stratified alluvium". The term is confined to geological material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are *platy* (laminated), *prismatic,* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Substratum. Any layer lying beneath the solum, or true soil; the C or R horizon.

Subsurface soil. The part of the soil between the surface soil and the subsoil.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surplus runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is kept in permanent sod.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Till, glacial (geology). See Drift.

Till plain. A level or undulating land surface covered by glacial till.

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. A soil in good tilth is friable and has high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil. Presumed fertile soil or soil material, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Variant, soil. A soil that has properties sufficiently different from those of other known soils to justify a new series name, but of such limited geographic area that establishing a new series cannot be justified.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

Wheel-track planting. Planting a crop at the time the soil is plowed, or soon after, without additional tillage for preparation of a seedbed. Sometimes called plow planting.

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U.S. GOVERNMENT PRINTING OFFICE: 1968

GUIDE TO MAPPING UNITS

[For a full description of a mapping unit, read both the description of the mapping unit and the description of the soil series to which the mapping unit belongs.

[See table 1, p. 6, for the acreage and proportionate extent of the soils, and table 2, p. 54, for predicted yields. To find the engineering properties of the soils, see the section beginning on p. 67].

Map symbol	Mapping unit	Described on page	Capability unit		Woodland suitability group		Building site group	
			Symbol	Page	Number	Page	Number	Page
Al	Alluvial land	8	VIw-1	51	11	67	11	100
Ba	Beach materials, sandy	9	VIIs-1	52	11	67	10	100
Bb	Becker loam	10	IIw-2	40	1	63	11	100
Bc	Biscay loam	10	IIw-1	40	10	66	9	99
Bd	Biscay loam, sandy subsoil variant	10	IIIw-4	45	10	66	9	99
Be	Blue Earth silt loam	11	IIIw-1	44	11	67	10	100
BhB2	Braham and Anoka fine sands, 2 to 6 percent slopes, moderately eroded	11	IIIs-3	46	6	65	1	96
BhC2	Braham and Anoka fine sands, 6 to 12 percent slopes, moderately eroded	11	IVs-3	49	6	65	2	96
BhD	Braham and Anoka fine sands, 12 to 25 percent slopes	11	VIIs-1	52	7	65	3	97
BrA	Braham and Anoka loamy fine sands, 0 to 2 percent slopes	11	IIIs-3	46	6	65	1	96
BrB	Braham and Anoka loamy fine sands, 2 to 6 percent slopes	11	IIIs-3	46	6	65	1	96
BrC	Braham and Anoka loamy fine sands, 6 to 12 percent slopes	11	IVs-3	49	6	65	2	96
BuB	Burnsville soils, 0 to 6 percent slopes	12	IIIe-5	43	4	64	1	96
BuB2	Burnsville soils, 2 to 6 percent slopes, moderately eroded	12	IIIe-5	43	4	64	1	96
BuC	Burnsville soils, 6 to 12 percent slopes	12	IVe-3	48	4	64	2	96
BuC2	Burnsville soils, 6 to 12 percent slopes, moderately eroded	12	IVe-3	48	4	64	2	96
BuC3	Burnsville soils, 6 to 12 percent slopes, severely eroded	12	VIe-2	50	4	64	2	96
BuD	Burnsville soils, 12 to 18 percent slopes	13	VIe-2	50	5	64	3	97
BuD3	Burnsville soils, 12 to 25 percent slopes, severely eroded	13	VIIe-2	52	5	64	3	97
Bue	Burnsville soils, 18 to 35 percent slopes	13	VIIe-2	52	5	64	3	97
ByB	Burnsville-Hayden complex, 2 to 6 percent slopes	13	IIIe-5	43	4	64	4	98
ByB2	Burnsville-Hayden complex, 2 to 6 percent slopes, moderately eroded	13	IIIe-5	43	4	64	4	98
ByC	Burnsville-Hayden complex, 6 to 12 percent slopes	13	IVe-3	48	4	64	5	98
ByC2	Burnsville-Hayden complex, 6 to 12 percent slopes, moderately eroded	13	IVe-3	48	4	64	5	98
ByD	Burnsville-Hayden complex, 12 to 18 percent slopes	13	VIe-2	50	5	64	6	98
ByE	Burnsville-Hayden complex, 18 to 35 percent slopes	13	VIIe-2	52	5	64	7	99
Ca	Canisteo silty clay loam	14	IIw-1	40	10	66	9	99
ChB	Chelsea fine sand, 2 to 6 percent slopes	14	IVs-1	49	6	65	1	96
ChC	Chelsea fine sand, 6 to 12 percent slopes	14	VIs-1	51	6	65	2	96
ChD	Chelsea fine sand, 12 to 18 percent slopes	14	VIIs-1	52	7	65	3	97
Cn	Clayey basin land	15	IIIw-1	44	11	67	10	100
Co	Comfrey silty clay loam	15	VIw-1	51	11	67	11	100
Cp	Comfrey silty clay loam, depressional	15	VIw-1	51	11	67	11	100
Cs	Cordova and Le Sueur silty clay loams	15	IIw-1	40	10	66	9	99
Cw	Cordova and Webster silty clay loams	16	IIw-1	40	10	66	9	99
De	Duelm and Watseka soils	16	IIIw-4	45	10	66	8	99
Dn	Dundas silt loam	16	IIIw-2	44	10	66	9	99

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit		Woodland suitability group		Building site group	
			Symbol	Page	Number	Page	Number	Page
Du	Dundas and Ames silt loams	16	IIIw-2	44	10	66	9	99
EmB	Emmert-Milaca complex, 2 to 6 percent slopes	17	IIIe-5	43	4	64	4	98
EmC	Emmert-Milaca complex, 6 to 12 percent slopes	17	IVe-3	48	4	64	5	98
EmD	Emmert-Milaca complex, 12 to 18 percent slopes	17	VIe-2	50	5	64	6	98
EmE	Emmert-Milaca complex, 18 to 35 percent slopes	17	VIIe-2	52	5	64	7	99
EsA	Estherville loam, 0 to 2 percent slopes	17	IIIs-2	46	4	64	1	96
EsB	Estherville loam, 2 to 6 percent slopes	17	IIIe-5	43	4	64	1	96
EsB2	Estherville loam, 2 to 6 percent slopes, moderately eroded	18	IIIe-5	43	4	64	1	96
EsC	Estherville loam, 6 to 12 percent slopes	18	IVe-3	48	4	64	2	96
EsC2	Estherville loam, 6 to 12 percent slopes, moderately eroded	18	IVe-3	48	4	64	2	96
EtA	Estherville sandy loam, 0 to 2 percent slopes	18	IIIs-2	46	4	64	1	96
EtB	Estherville sandy loam, 2 to 6 percent slopes	18	IIIe-5	43	4	64	1	96
EtB2	Estherville sandy loam, 2 to 6 percent slopes, moderately eroded	18	IIIe-5	43	4	64	1	96
EtC	Estherville sandy loam, 6 to 12 percent slopes	18	IVe-3	48	4	64	2	96
EtC2	Estherville sandy loam, 6 to 12 percent slopes, moderately eroded	18	IVe-3	48	4	64	2	96
EtD	Estherville sandy loam, 12 to 18 percent slopes	18	VIe-2	50	5	64	3	97
EtE	Estherville sandy loam, 18 to 25 percent slopes	19	VIIe-2	52	5	64	3	97
EvC3	Estherville soils, 6 to 12 percent slopes, severely eroded	19	VIe-2	50	4	64	2	96
EvE3	Estherville soils, 12 to 25 percent slopes, severely eroded	19	VIIe-2	52	5	64	3	97
FaA	Fairhaven silt loam, 0 to 2 percent slopes	19	IIs-1	40	1	63	1	96
FaB	Fairhaven silt loam, 2 to 6 percent slopes	19	IIe-4	39	1	63	1	96
FaB2	Fairhaven silt loam, 2 to 6 percent slopes, moderately eroded	19	IIe-4	39	1	63	1	96
FaC2	Fairhaven silt loam, 6 to 12 percent slopes, moderately eroded	19	IIIe-3	42	2	64	2	96
Gc	Glencoe silty clay loam	20	IIIw-1	44	11	67	10	100
GuA	Guckeen silty clay loam, 0 tc 2 percent slopes	20	I-1	37	1	63	8	99
GuB	Guckeen silty clay loam, 2 to 6 percent slopes	20	IIe-1	37	1	63	8	99
GuC	Guckeen silty clay loam, 6 to 12 percent slopes	20	IIIe-1	41	2	64	8	99
HaC3	Hayden clay loam, 6 to 12 percent slopes, severely eroded	20	IVe-1	47	2	64	5	98
HaD3	Hayden clay loam, 12 to 18 percent slopes, severely eroded	20	VIe-1	50	2	64	6	98
HdA	Hayden fine sandy loam, 0 to 2 percent slopes	21	IIe-3	38	1	63	4	98
HdB	Hayden fine sandy loam, 2 to 6 percent slopes	21	IIe-3	38	1	63	4	98
HdB2	Hayden fine sandy loam, 2 to 6 percent slopes, moderately eroded	21	IIe-3	38	1	63	4	98
HdC	Hayden fine sandy loam, 6 to 12 percent slopes	21	IIIe-2	41	2	64	5	98
HdC2	Hayden fine sandy loam, 6 to 12 percent slopes, moderately eroded	21	IIIe-2	41	2	64	5	98
HdD	Hayden fine sandy loam, 12 to 18 percent slopes	22	IVe-1	47	2	64	6	98
HdD2	Hayden fine sandy loam, 12 to 18 percent slopes, moderately eroded	22	IVe-1	47	2	64	6	98
HlB	Hayden loam, 2 to 6 percent slopes	22	IIe-3	38	1	63	4	98
HlB2	Hayden loam, 2 to 6 percent slopes, moderately eroded	22	IIe-3	38	1	63	4	98
HlC	Hayden loam, 6 to 12 percent slopes	22	IIIe-2	41	2	64	5	98
HlC2	Hayden loam, 6 to 12 percent slopes, moderately eroded	22	IIIe-2	41	2	64	5	98
HlD	Hayden loam, 12 to 18 percent slopes	22	IVe-1	47	2	64	6	98

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit		Woodland suitability group		Building site group	
			Symbol	Page	Number	Page	Number	Page
HlD2	Hayden loam 12 to 18 percent slopes, moderately eroded	22	IVe-1	47	2	64	6	98
HlE	Hayden loam, 18 to 25 percent slopes	22	VIe-1	50	3	64	7	99
HlF	Hayden loam, 25 to 35 percent slopes	23	VIIe-1	52	3	64	7	99
HnE3	Hayden soils, 18 to 25 percent slopes, severely eroded	23	VIIe-1	52	3	64	7	99
HrA	Hubbard loamy sand, 0 to 2 percent slopes	23	IVs-1	49	6	65	1	96
HrB	Hubbard loamy sand, 2 to 6 percent slopes	24	IVs-1	49	6	65	1	96
HrB2	Hubbard loamy sand, 2 to 6 percent slopes, moderately eroded	24	IVs-1	49	6	65	1	96
HrC	Hubbard loamy sand, 6 to 12 percent slopes	24	VIs-1	51	6	65	2	96
HrC2	Hubbard loamy sand, 6 to 12 percent slopes, moderately eroded	24	VIs-1	51	6	65	2	96
HrE2	Hubbard loamy sand, 12 to 35 percent slopes, moderately eroded	24	VIIs-1	52	7	65	3	97
HsA	Hubbard loamy sand, gravelly subsoil variant, 0 to 2 percent slopes	25	IVs-2	49	8	66	1	96
HsB	Hubbard loamy sand, gravelly subsoil variant, 2 to 6 percent slopes	25	IVs-2	49	8	66	1	96
HsB2	Hubbard loamy sand, gravelly subsoil variant, 2 to 6 percent slopes, moderately eroded	25	IVs-2	49	8	66	1	96
HsC	Hubbard loamy sand, gravelly subsoil variant, 6 to 12 percent slopes	25	VIIs-2	53	8	66	2	96
HuA	Hubbard sandy loam, 0 to 2 percent slopes	24	IIIs-1	46	4	64	1	96
HuA2	Hubbard sandy loam, 0 to 2 percent slopes, moderately eroded	24	IIIs-1	46	4	64	1	96
HuB	Hubbard sandy loam, 2 to 6 percent slopes	24	IIIe-4	43	4	64	1	96
HuB2	Hubbard sandy loam, 2 to 6 percent slopes, moderately eroded	24	IIIe-4	43	4	64	1	96
HuC	Hubbard sandy loam, 6 to 12 percent slopes	24	IVe-2	48	4	64	2	96
HuC2	Hubbard sandy loam, 6 to 12 percent slopes, moderately eroded	24	IVe-2	48	4	64	2	96
Lb	Lake borders	25	IIIw-1	44	11	67	10	100
LcC3	Lester clay loam, 6 to 12 percent slopes, severely eroded	25	IVe-1	47	2	64	5	98
LcD3	Lester clay loam, 12 to 18 percent slopes, severely eroded	26	VIe-1	50	2	64	6	98
LcE3	Lester clay loam, 18 to 25 percent slopes, severely eroded	26	VIIe-1	52	3	64	7	99
LeB	Lester loam, 2 to 6 percent slopes	26	IIe-2	37	1	63	4	98
LeB2	Lester loam, 2 to 6 percent slopes, moderately eroded	26	IIe-2	37	1	63	4	98
LeC	Lester loam, 6 to 12 percent slopes	26	IIIe-1	41	2	64	5	98
LeC2	Lester loam, 6 to 12 percent slopes, moderately eroded	27	IIIe-1	41	2	64	5	98
LeD	Lester loam, 12 to 18 percent slopes	27	IVe-1	47	2	64	6	98
LeE	Lester loam, 18 to 25 percent slopes	27	VIe-1	50	3	64	7	99
LeF	Lester loam, 25 to 35 percent slopes	27	VIIe-1	52	3	64	7	99
LrA	Lester silt loam, silty variant, 0 to 2 percent slopes	28	I-1	37	1	63	4	98
LrB	Lester silt loam, silty variant, 2 to 6 percent slopes	28	IIe-2	37	1	63	4	98
LrB2	Lester silt loam, silty variant, 2 to 6 percent slopes, moderately eroded	28	IIe-2	37	1	63	4	98
LrC2	Lester silt loam, silty variant, 6 to 12 percent slopes, moderately eroded	28	IIIe-1	41	2	64	5	98
LtB	Lester-Estherville complex, 2 to 6 percent slopes	27	IIe-4	39	1	63	4	98
LtB2	Lester-Estherville complex, 2 to 6 percent slopes, moderately eroded	27	IIe-4	39	1	63	4	98

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit		Woodland suitability group		Building site group	
			Symbol	Page	Number	Page	Number	Page
LtC	Lester-Estherville complex, 6 to 12 percent slopes	27	IVe-3	48	4	64	5	98
LtD	Lester-Estherville complex, 12 to 18 percent slopes	27	VIe-2	50	5	64	6	98
LuA	Le Sueur clay loam, 0 to 2 percent slopes	28	I-1	37	1	63	8	99
LuB	Le Sueur clay loam, 2 to 6 percent slopes	28	IIe-1	37	1	63	8	99
Ma	Marna silty clay loam	29	IIw-1	40	10	66	9	99
Mh	Marsh	29	VIIIw-1	53	11	67	10	100
MlB2	Milaca loam, 2 to 6 percent slopes, moderately eroded	29	IIe-3	38	1	63	4	98
Mu	Muck, deep	29	IIIw-3	45	11	67	10	100
NeA	Nessel silt loam, 0 to 2 percent slopes	30	IIe-3	38	1	63	8	99
NeB	Nessel silt loam, 2 to 6 percent slopes	30	IIe-3	38	1	63	8	99
Pa	Peat and muck, deep	30	IIIw-3	45	11	67	10	100
Pm	Peat and muck, shallow over loam	30	IIIw-3	45	11	67	10	100
Ps	Peat and muck, shallow over sand	30	Vw-1	50	11	67	10	100
RhA	Rasset and Hubbard soils, 0 to 2 percent slopes	31	IIIs-1	46	4	64	1	96
RhB	Rasset and Hubbard soils, 2 to 6 percent slopes	31	IIIe-4	43	4	64	1	96
RhB2	Rasset and Hubbard soils, 2 to 6 percent slopes, moderately eroded	31	IIIe-4	43	4	64	1	96
RhC	Rasset and Hubbard soils, 6 to 12 percent slopes	31	IVe-2	48	4	64	2	96
RhC2	Rasset and Hubbard soils, 6 to 12 percent slopes, moderately eroded	31	IVe-2	48	4	64	2	96
SaB	Salida gravelly sandy loam, 2 to 6 percent slopes	31	IVs-2	49	8	66	1	96
SaC	Salida gravelly sandy loam, 6 to 12 percent slopes	31	VIIs-2	53	8	66	2	96
SaE	Salida gravelly sandy loam, 12 to 35 percent slopes	31	VIIs-2	53	9	66	3	97
ScB	Salida complex, 2 to 6 percent slopes	31	IVs-2	49	8	66	1	96
ScC	Salida complex, 6 to 12 percent slopes	32	VIIs-2	53	8	66	2	96
ScE	Salida complex, 12 to 35 percent slopes	32	VIIs-2	53	9	66	3	97
SeA	Sattre silt loam, silty variant, 0 to 2 percent slopes	32	IIs-1	40	1	63	1	96
SeB	Sattre silt loam, silty variant, 2 to 6 percent slopes	32	IIe-4	39	1	63	1	96
SlC2	Storden-Lester loams, 6 to 12 percent slopes, moderately eroded	32	IIIe-1	41	2	64	5	98
SlD2	Storden-Lester loams, 12 to 18 percent slopes, moderately eroded	33	IVe-1	47	2	64	6	98
SlE2	Storden-Lester loams, 18 to 25 percent slopes, moderately eroded	33	VIe-1	50	3	64	7	99
StC3	Storden-Lester soils, 6 to 12 percent slopes, severely eroded	33	IVe-1	47	2	64	5	98
StD3	Storden-Lester soils, 12 to 18 percent slopes, severely eroded	33	VIe-1	50	2	64	6	98
Tc	Talcot clay loam	33	IIIw-1	44	11	67	10	100
TeA	Terril loam, occasionally flooded, 0 to 2 percent slopes	34	IIw-2	40	1	63	11	100
TlA	Terril loam, sandy substratum, 0 to 2 percent slopes	34	I-1	37	1	63	8	99
TsB	Terril soils, 2 to 6 percent slopes	34	IIe-1	37	1	63	8	99
WaA	Wadena loam, 0 to 2 percent slopes	34	IIs-1	40	1	63	1	96
WaB	Wadena loam, 2 to 6 percent slopes	34	IIe-4	39	1	63	1	96
WaB2	Wadena loam, 2 to 6 percent slopes, moderately eroded	34	IIe-4	39	1	63	1	96
WaC2	Wadena loam, 6 to 12 percent slopes, moderately eroded	34	IIIe-3	42	2	64	2	96
We	Webster silty clay loam, silty variant	35	IIw-1	40	10	66	9	99

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U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MINNESOTA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP
WRIGHT COUNTY, MINNESOTA

SCALE IN MILES
1 0 1 2 3 4

N

T. 123 N.
T. 122 N.
T. 121 N.
T. 120 N.
T. 119 N.
T. 118 N.
94°00′
94°10′
93°50′
93°40′
45°20′
45°10′
45°00′
R. 28 W.
R. 27 W.
R. 26 W.
R. 25 W.
R. 24 W.
R. 23 W.

Clearwater
Hasty
Silver Creek
Monticello
Otsego
Albertville
St Michael
Dayton
Annandale
South Haven
Maple Lake
French Lake
BUFFALO
Howard Lake
Waverly
Montrose
Cokato
Delano
Rockford
Hanover

CO River
Fish Cr
Sugar Lake
Clearwater Lake
Pleasant Lake
Lake John
Twin Lake
Lake Sylvia
Ida Lake
Otter Cr
Ceda Lake
Silver Cr
Lake Mary
Maple Lake
Lake Francie
French Lake
French Cr
North Fork
Granite Lake
Mill Cr
Lake Pulaski
Buffalo Lake
Mary Lake
Beebe Lake
Charlotte Lake
Pelican Lake
Crow River
Cokato Lake
Cokato Creek
Howard Lake
Little Waverly Lake
Waverly Lake
Collinwood Lake
Sucker Cr
Lake Ann
Lake Emma
Lake Ida
Fountain Lake
South Fk Crow River
Frederick Cr
Middle Fork Crow River

SHERBURNE
STEARNS
MEEKER
COUNTY
ANOKA CO
HENNEPIN CO
MC LEOD CO
CARVER CO

PROPOSED GREAT MISSISSIPPI RIVER INTERSTATE HIGHWAY 94
GREAT NORTHERN RAILWAY
SOO LINE
NORTHERN HIGHWAY 94
CO DITCH NO 10

SOIL ASSOCIATIONS

1 Lester-Le Sueur-Cordova association: Deep, medium textured and moderately fine textured soils on nearly level and gently sloping uplands

2 Lester-Hayden-peat association: Deep, medium textured and moderately fine textured soils on rolling uplands

3 Hayden-Dundas-peat association: Deep, medium textured and moderately fine textured soils on gently rolling uplands

4 Hayden-Lester-peat association: Deep, medium textured and moderately fine textured soils on strongly rolling and hilly uplands

5 Emmert-Milaca-peat association: Shallow and deep, moderately coarse textured and medium textured soils on steep uplands

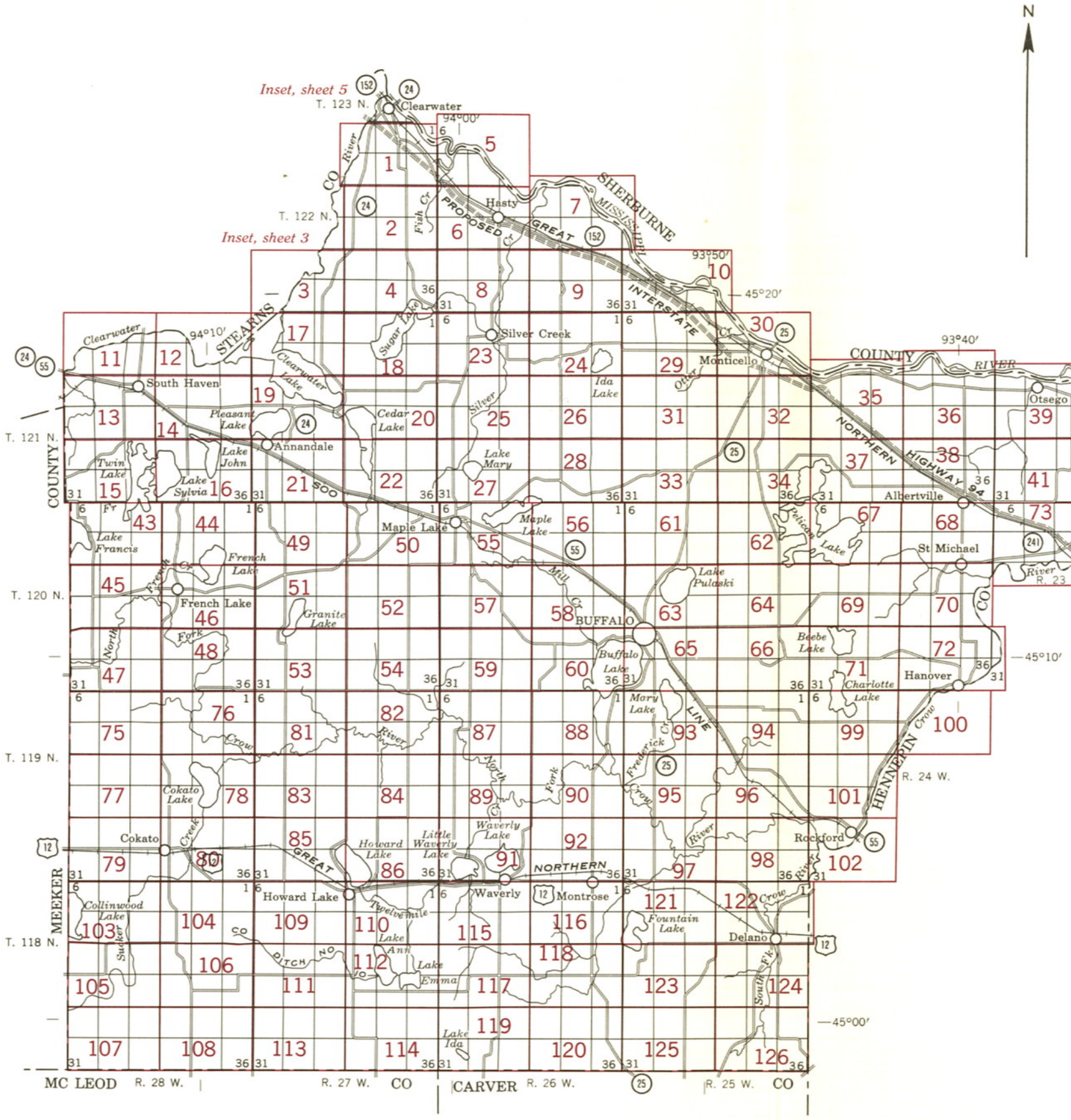
6 Burnsville-Hayden-peat association: Shallow and deep, moderately coarse textured and medium textured soils on very steep uplands

7 Estherville-Hubbard-Wadena association: Shallow and moderately deep, moderately coarse textured and medium textured soils on nearly level and undulating outwash plains and terraces

July 1966

INDEX TO MAP SHEETS
WRIGHT COUNTY, MINNESOTA

SCALE IN MILES
1 0 1 2 3 4



WRIGHT COUNTY, MINNESOTA
CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Dual
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail, foot
- Railroad
- Ferries
- Ford
- Grade
- R. R. over
- R. R. under
- Tunnel

Buildings
- School
- Church
- Station

Mines and Quarries
- Mine dump
- Pits, gravel or other

Power lines
Pipe lines
Cemeteries
Dams
Levees
Tanks
Oil or gas wells

BOUNDARIES
- National or state
- County
- Township, U. S.
- Section line, corner
- Reservation
- Land grant

DRAINAGE
Streams
- Perennial
- Intermittent, unclass.
- Crossable with tillage implements

Canals and ditches — CANAL / DITCH

Lakes and ponds
- Perennial
- Intermittent

Wells — flowing
Springs
Marsh
Wet spot
Alluvial fan
Drainage ends

RELIEF
Escarpments
- Bedrock
- Other

Prominent peaks

Depressions — Large / Small
- Crossable with tillage implements
- Not crossable with tillage implements
- Contains water most of the time

SOIL SURVEY DATA
- Soil boundary and symbol — Dx
- Gravel
- Stones
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gullies
- Small area of high lime soil — A

SOIL LEGEND

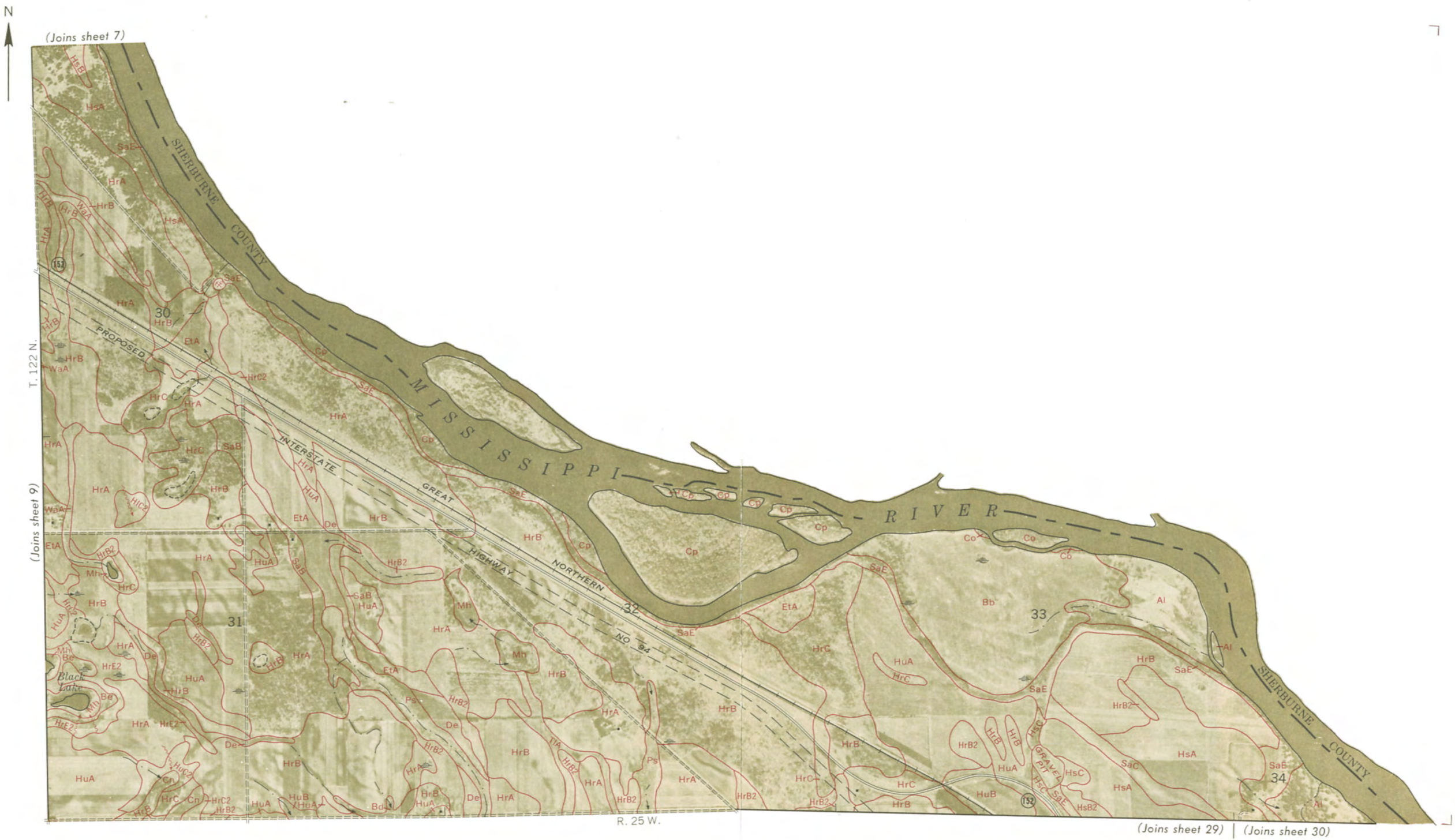
The first capital letter is the initial one of the soil name. A second capital letter, A, B, C, D, E, or F, shows the slope. Some symbols without a slope letter are for nearly level soils or land types, but some are for soils or land types that have a considerable range in slope. The number, 2 or 3, in a symbol indicates that the soil is eroded or severely eroded.

SYMBOL	NAME
Al	Alluvial land
Ba	Beach materials, sandy
Bb	Becker loam
Bc	Biscay loam
Bd	Biscay loam, sandy subsoil variant
Be	Blue Earth silt loam
BhB2	Braham and Anoka fine sands, 2 to 6 percent slopes, moderately eroded
BhC2	Braham and Anoka fine sands, 6 to 12 percent slopes, moderately eroded
BhD	Braham and Anoka fine sands, 12 to 25 percent slopes
BrA	Braham and Anoka loamy fine sands, 0 to 2 percent slopes
BrB	Braham and Anoka loamy fine sands, 2 to 6 percent slopes
BrC	Braham and Anoka loamy fine sands, 6 to 12 percent slopes
BuB	Burnsville soils, 0 to 6 percent slopes
BuB2	Burnsville soils, 2 to 6 percent slopes, moderately eroded
BuC	Burnsville soils, 6 to 12 percent slopes
BuC2	Burnsville soils, 6 to 12 percent slopes, moderately eroded
BuC3	Burnsville soils, 6 to 12 percent slopes, severely eroded
BuD	Burnsville soils, 12 to 18 percent slopes
BuD3	Burnsville soils, 12 to 25 percent slopes, severely eroded
BuE	Burnsville soils, 18 to 35 percent slopes
ByB	Burnsville–Hayden complex, 2 to 6 percent slopes
ByB2	Burnsville–Hayden complex, 2 to 6 percent slopes, moderately eroded
ByC	Burnsville–Hayden complex, 6 to 12 percent slopes
ByC2	Burnsville–Hayden complex, 6 to 12 percent slopes, moderately eroded
ByD	Burnsville–Hayden complex, 12 to 18 percent slopes
ByE	Burnsville–Hayden complex, 18 to 35 percent slopes
Ca	Canisteo silty clay loam
ChB	Chelsea fine sand, 2 to 6 percent slopes
ChC	Chelsea fine sand, 6 to 12 percent slopes
ChD	Chelsea fine sand, 12 to 18 percent slopes
Cn	Clayey basin land
Co	Comfrey silty clay loam
Cp	Comfrey silty clay loam, depressional
Cs	Cordova and Le Sueur silty clay loams
Cw	Cordova and Webster silty clay loams
De	Duelm and Watseka soils
Dn	Dundas silt loam
Du	Dundas and Ames silt loams
EmB	Emmert–Milaca complex, 2 to 6 percent slopes
EmC	Emmert–Milaca complex, 6 to 12 percent slopes
EmD	Emmert–Milaca complex, 12 to 18 percent slopes
EmE	Emmert–Milaca complex, 18 to 35 percent slopes
EsA	Estherville loam, 0 to 2 percent slopes
EsB	Estherville loam, 2 to 6 percent slopes
EsB2	Estherville loam, 2 to 6 percent slopes, moderately eroded
EsC	Estherville loam, 6 to 12 percent slopes
EsC2	Estherville loam, 6 to 12 percent slopes, moderately eroded
EtA	Estherville sandy loam, 0 to 2 percent slopes
EtB	Estherville sandy loam, 2 to 6 percent slopes
EtB2	Estherville sandy loam, 2 to 6 percent slopes, moderately eroded
EtC	Estherville sandy loam, 6 to 12 percent slopes
EtC2	Estherville sandy loam, 6 to 12 percent slopes, moderately eroded
EtD	Estherville sandy loam, 12 to 18 percent slopes
EtE	Estherville sandy loam, 18 to 25 percent slopes
EvC3	Estherville soils, 6 to 12 percent slopes, severely eroded
EvE3	Estherville soils, 12 to 25 percent slopes, severely eroded
FaA	Fairhaven silt loam, 0 to 2 percent slopes
FaB	Fairhaven silt loam, 2 to 6 percent slopes
FaB2	Fairhaven silt loam, 2 to 6 percent slopes, moderately eroded
FaC2	Fairhaven silt loam, 6 to 12 percent slopes, moderately eroded
Gc	Glencoe silty clay loam
GuA	Guckeen silty clay loam, 0 to 2 percent slopes
GuB	Guckeen silty clay loam, 2 to 6 percent slopes
GuC	Guckeen silty clay loam, 6 to 12 percent slopes
HaC3	Hayden clay loam, 6 to 12 percent slopes, severely eroded
HaD3	Hayden clay loam, 12 to 18 percent slopes, severely eroded
HdA	Hayden fine sandy loam, 0 to 2 percent slopes
HdB	Hayden fine sandy loam, 2 to 6 percent slopes
HdB2	Hayden fine sandy loam, 2 to 6 percent slopes, moderately eroded
HdC	Hayden fine sandy loam, 6 to 12 percent slopes
HdC2	Hayden fine sandy loam, 6 to 12 percent slopes, moderately eroded
HdD	Hayden fine sandy loam, 12 to 18 percent slopes
HdD2	Hayden fine sandy loam, 12 to 18 percent slopes, moderately eroded
HlB	Hayden loam, 2 to 6 percent slopes
HlB2	Hayden loam, 2 to 6 percent slopes, moderately eroded
HlC	Hayden loam, 6 to 12 percent slopes
HlC2	Hayden loam, 6 to 12 percent slopes, moderately eroded
HlD	Hayden loam, 12 to 18 percent slopes
HlD2	Hayden loam, 12 to 18 percent slopes, moderately eroded
HlE	Hayden loam, 18 to 25 percent slopes
HlF	Hayden loam, 25 to 35 percent slopes
HnE3	Hayden soils, 18 to 25 percent slopes, severely eroded
HrA	Hubbard loamy sand, 0 to 2 percent slopes
HrB	Hubbard loamy sand, 2 to 6 percent slopes
HrB2	Hubbard loamy sand, 2 to 6 percent slopes, moderately eroded
HrC	Hubbard loamy sand, 6 to 12 percent slopes
HrC2	Hubbard loamy sand, 6 to 12 percent slopes, moderately eroded
HrE2	Hubbard loamy sand, 12 to 35 percent slopes, moderately eroded
HsA	Hubbard loamy sand, gravelly subsoil variant, 0 to 2 percent slopes
HsB	Hubbard loamy sand, gravelly subsoil variant, 2 to 6 percent slopes
HsB2	Hubbard loamy sand, gravelly subsoil variant, 2 to 6 percent slopes, moderately eroded
HsC	Hubbard loamy sand, gravelly subsoil variant, 6 to 12 percent slopes
HuA	Hubbard sandy loam, 0 to 2 percent slopes
HuA2	Hubbard sandy loam, 0 to 2 percent slopes, moderately eroded
HuB	Hubbard sandy loam, 2 to 6 percent slopes
HuB2	Hubbard sandy loam, 2 to 6 percent slopes, moderately eroded
HuC	Hubbard sandy loam, 6 to 12 percent slopes
HuC2	Hubbard sandy loam, 6 to 12 percent slopes, moderately eroded
Lb	Lake borders
LcC3	Lester clay loam, 6 to 12 percent slopes, severely eroded
LcD3	Lester clay loam, 12 to 18 percent slopes, severely eroded
LcE3	Lester clay loam, 18 to 25 percent slopes, severely eroded
LeB	Lester loam, 2 to 6 percent slopes
LeB2	Lester loam, 2 to 6 percent slopes, moderately eroded
LeC	Lester loam, 6 to 12 percent slopes
LeC2	Lester loam, 6 to 12 percent slopes, moderately eroded
LeD	Lester loam, 12 to 18 percent slopes
LeE	Lester loam, 18 to 25 percent slopes
LeF	Lester loam, 25 to 35 percent slopes
LrA	Lester silt loam, silty variant, 0 to 2 percent slopes
LrB	Lester silt loam, silty variant, 2 to 6 percent slopes
LrB2	Lester silt loam, silty variant, 2 to 6 percent slopes, moderately eroded
LrC2	Lester silt loam, silty variant, 6 to 12 percent slopes, moderately eroded
LtB	Lester–Estherville complex, 2 to 6 percent slopes
LtB2	Lester–Estherville complex, 2 to 6 percent slopes, moderately eroded
LtC	Lester–Estherville complex, 6 to 12 percent slopes
LtD	Lester–Estherville complex, 12 to 18 percent slopes
LuA	Le Sueur clay loam, 0 to 2 percent slopes
LuB	Le Sueur clay loam, 2 to 6 percent slopes
Ma	Marna silty clay loam
Mh	Marsh
MlB2	Milaca loam, 2 to 6 percent slopes, moderately eroded
Mu	Muck, deep
NeA	Nessel silt loam, 0 to 2 percent slopes
NeB	Nessel silt loam, 2 to 6 percent slopes
Pa	Peat and muck, deep
Pm	Peat and muck, shallow over loam
Ps	Peat and muck, shallow over sand
RhA	Rasset and Hubbard soils, 0 to 2 percent slopes
RhB	Rasset and Hubbard soils, 2 to 6 percent slopes
RhB2	Rasset and Hubbard soils, 2 to 6 percent slopes, moderately eroded
RhC	Rasset and Hubbard soils, 6 to 12 percent slopes
RhC2	Rasset and Hubbard soils, 6 to 12 percent slopes, moderately eroded
SaB	Salida gravelly sandy loam, 2 to 6 percent slopes
SaC	Salida gravelly sandy loam, 6 to 12 percent slopes
SaE	Salida gravelly sandy loam, 12 to 35 percent slopes
ScB	Salida complex, 2 to 6 percent slopes
ScC	Salida complex, 6 to 12 percent slopes
ScE	Salida complex, 12 to 35 percent slopes
SeA	Sattre silt loam, silty variant, 0 to 2 percent slopes
SeB	Sattre silt loam, silty variant, 2 to 6 percent slopes
SlC2	Storden–Lester loams, 6 to 12 percent slopes, moderately eroded
SlD2	Storden–Lester loams, 12 to 18 percent slopes, moderately eroded
SlE2	Storden–Lester loams, 18 to 25 percent slopes, moderately eroded
StC3	Storden–Lester soils, 6 to 12 percent slopes, severely eroded
StD3	Storden–Lester soils, 12 to 18 percent slopes, severely eroded
Tc	Talcot clay loam
TeA	Terril loam, occasionally flooded, 0 to 2 percent slopes
TlA	Terril loam, sandy substratum, 0 to 2 percent slopes
TsB	Terril soils, 2 to 6 percent slopes
WaA	Wadena loam, 0 to 2 percent slopes
WaB	Wadena loam, 2 to 6 percent slopes
WaB2	Wadena loam, 2to 6 percent slopes, moderately eroded
WaC2	Wadena loam, 6 to 12 percent slopes, moderately eroded
We	Webster silty clay loam, silty variant

Soil map constructed 1966 by Cartographic Division, Soil Conservation Service, USDA, from 1957 aerial photographs. Controlled mosaic based on Minnesota plane coordinate system, south zone, Lambert conformal conic projection, 1927 North American datum.


R. 27 W.
(Joins inset, sheet 5)
N
T. 122 N.
(Joins sheet 5)
MISSISSIPPI — RIVER
SHERBURNE COUNTY
INTERCHANGE
PROPOSED
INTERSTATE
HIGHWAY
NO 94
GREAT NORTHERN
ST LUKE CEMETERY
MT HOPE CEMETERY
CLEARWATER RIVER
STEARNS COUNTY
FISH LAKE
(Inset, sh 3)
(Joins sheet 2)

(10)


N
(Joins sheet 7)
SHERBURNE COUNTY
MISSISSIPPI RIVER
PROPOSED INTERSTATE
GREAT NORTHERN HIGHWAY
NO 94
30
31
32
33
34
Black Lake
GRAVEL PIT
T. 122 N.
R. 25 W.
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(Joins sheet 30)

100


N
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R. 24 W.
T. 119 N.
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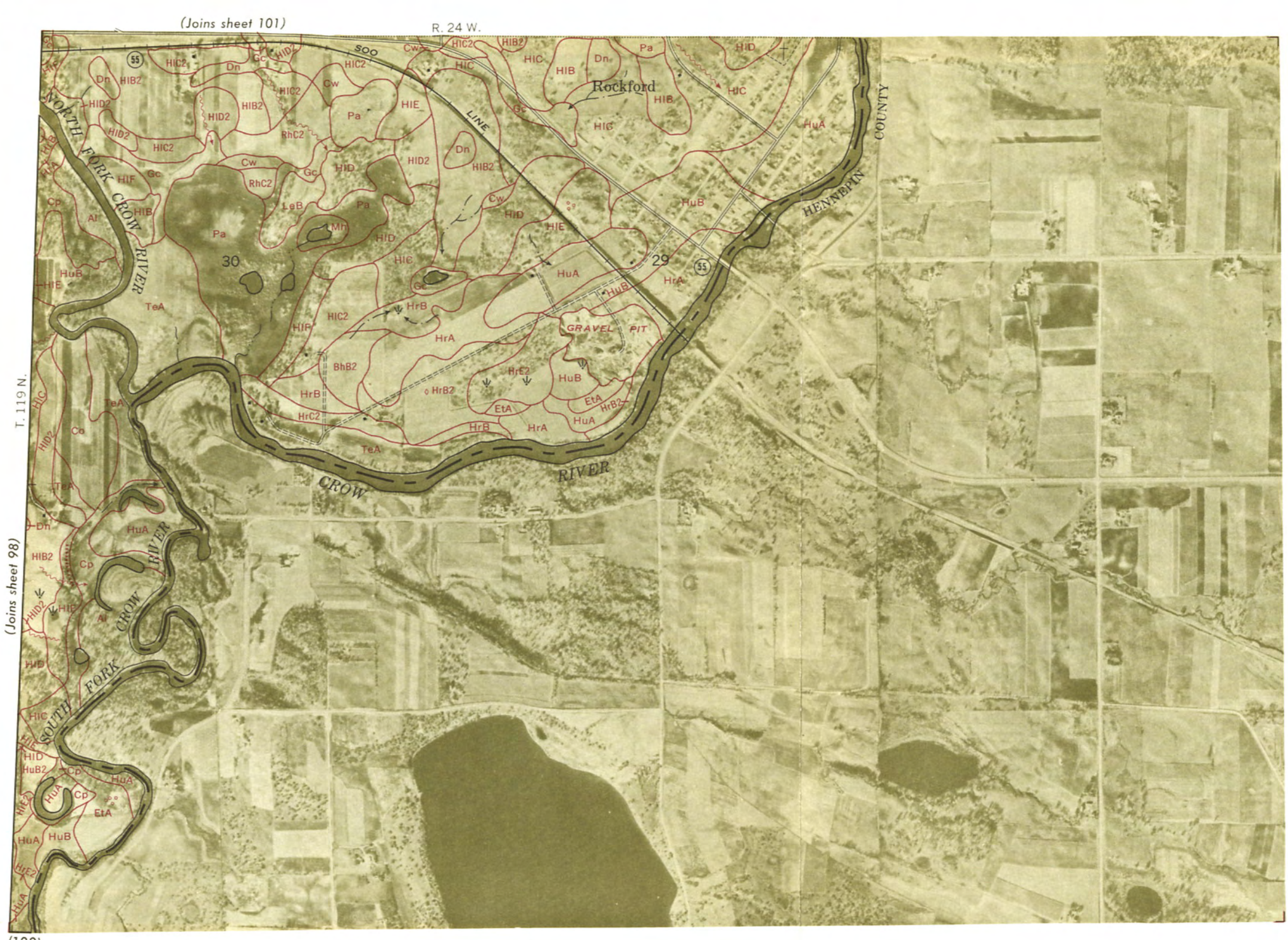
HENNEPIN COUNTY
CROW RIVER
3
HIB2
HID2
HIC
HIC2
HIE
Gc
Dn
Cw
Mh
ByE
ByD
HuB
HsB2
EtC2
EtD
EtC
EtB2
TeA
Cp
Bb
Co
De
ByC2


N
(Joins sheet 99)
R. 24 W.
T. 119 N.
(Joins sheet 96)
(Joins sheet 102)
HENNEPIN COUNTY
CROW RIVER
16
17
18
19
20
55

102


N
(Joins sheet 101)
R. 24 W.
SOO LINE
Rockford
NORTH FORK CROW RIVER
HENNEPIN COUNTY
30
29
GRAVEL PIT
CROW RIVER
SOUTH FORK CROW RIVER
T. 119 N.
(Joins sheet 98)
(122)


N
R. 28 W.
(Joins sheet 79)
T. 118 N.
LAKE
COLLINWOOD
MEEKER COUNTY
Creek
Sucker
Stockholm
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(Joins sheet 105)

104

N

R. 28 W.

T. 118 N.

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(Joins sheet 103)

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(Joins sheet 106)

Glascoe School

Slough Lake

Grass Lake

1 2 3 10 11 12


(Joins sheet 103)
R. 28 W.
N
Stockholm
Maple Lake
Creek
Sucker Creek
GRAVEL PIT
T. 118 N.
MEEKER COUNTY
(Joins sheet 106)
(Joins sheet 107)
16
17
18
19
20
21

WRIGHT COUNTY, MINNESOTA — SHEET NUMBER 106

106

N

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T. 118 N.

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Grass Lake

North Grass Lake School

Rice Lake

15

14

13

22

23

24

N

(Joins sheet 105)

R. 28 W.

Sucker Creek

T. 118 N.

Dahl School

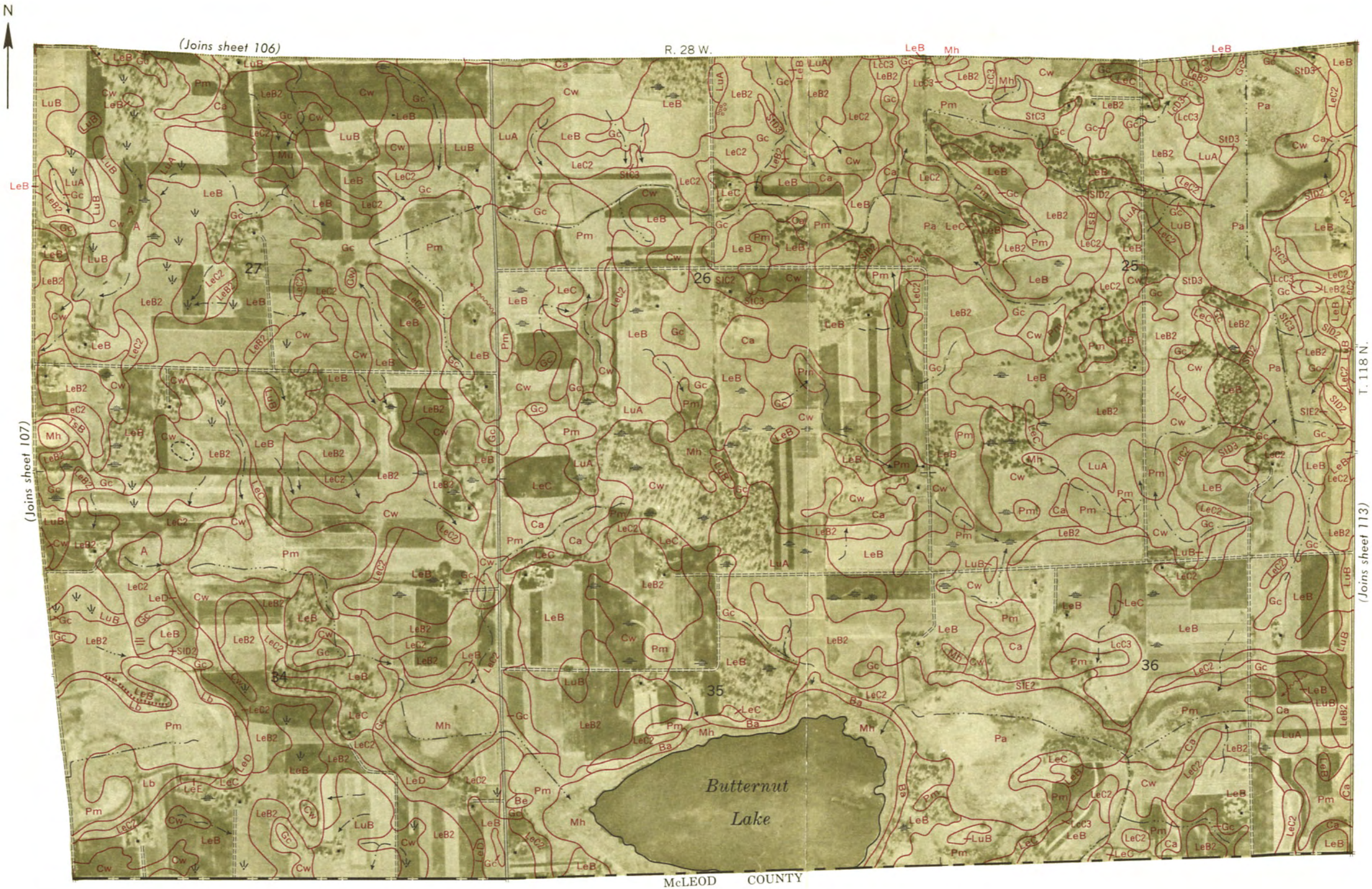
Shakopee Lake

30 29 28 31 32 33

(Joins sheet 108)

MEEKER COUNTY

McLEOD COUNTY


N
(Joins sheet 106)
R. 28 W.
(Joins sheet 107)
(Joins sheet 113)
T. 118 N.
27
26
25
34
35
36
Butternut Lake
McLEOD COUNTY


R. 27 W.
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T. 118 N.
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(Joins sheet 110)
(Joins sheet 111)
N
Howard Lake
Merriman School
Tuey Lake
Spring Lake
GREAT NORTHERN
GRAVEL PIT


N
CLEARWATER RIVER
LAKE CAROLINE
MILL POND
STEARNS COUNTY
LAKE MARIE
LAKE LOUISA
T. 121 N.
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(Joins sheet 13)
R. 28 W.
7
8
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4

110

N

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R. 27 W.

T. 118 N.

HOWARD LAKE

Howard Lake

Dutch Lake

Trout Brook

Creek

NORTHERN GREAT

ST JAMES CEMETERY

L Ann

Yager Lake

(Joins sheet 109)

(Joins sheet 112)

(Joins sheet 115)

N

R. 27 W.

(Joins sheet 109)

T. 118 N.

(Joins sheet 106)

(Joins sheet 112)

(Joins sheet 113)

COUNTY DITCH NO 10

Corey School

18 17 16

19 20 21

112

N

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R. 27 W.

T. 118 N.

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(Joins sheet 117)

(Joins sheet 114)

LAKE ANN

LAKE EMMA

Yager Lake

Round Lake

COUNTY DITCH NO 10

15 14 13 22 23 24


N
(Joins sheet 111)
R. 27 W.
T. 118 N.
(Joins sheet 108)
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30
29
28
31
32
33
Maple Lake
McLEOD COUNTY

WRIGHT COUNTY, MINNESOTA — SHEET NUMBER 114

114

N

(Joins sheet 112)

R. 27 W.

(Joins sheet 113)

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T. 118 N.

LONG LAKE

BUTLER LAKE

LAKE MARY

Round Lake

Nylanda Church

27 26 25 34 35 36

McLEOD COUNTY


N
R. 26 W.
T. 118 N.
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(Joins sheet 110)
(Joins sheet 116)
(Joins sheet 117)
Waverly
CARRIGAN LAKE
Yager Lake
Section Eight School
GREAT NORTHERN

N


(Joins sheet 92)
R. 26 W.
Montrose
Carrigan Lake
Fountain Lake
(Joins sheet 115)
(Joins sheet 118)
(Joins sheet 121)
T. 118 N.
1
2
3
10
11
12
25
36


N
R. 26 W.
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T. 118 N.
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Ruckles Lake
Louzers Lake
WOODLAND CEMETERY
16
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18
19
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N
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R. 26 W.
T. 118 N.
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Fountain Lake
Woodland School
15
14
13
22
23
24
25
LuB
LeB
LeB2
LeC
LeC2
LeD
LeD3
Pa
Pm
Gc
Cw
LuA
Ca
Mh
Al
SID2
SIC2
EtE
EsA
EtD
EsB2
LtB2
LtC
LtD
SaB
EtC
StC3
StC2
Mu
EsB
HIC
HIB

N

R. 26 W.

(Joins sheet 117)

T. 118 N.

(Joins sheet 114)

(Joins sheet 120)

Louzers Lake

Dog Lake

Lake Ida

Lake Ida School

McClelland School

Oster

30 29 28 31 32 33

CARVER COUNTY

12

N


LAKE CAROLINE
CLEARWATER RIVER
LAKE AUGUSTA
CLEARWATER LAKE
STEARNS COUNTY
Bungalow Island
10
11
12
Mh
ScE
Pa
BuB
BuE
BuB2
BuC2
FaA
Cw
WaA
Gc
Bc
BuC
EvE3
Pm
BuD
SeA
SeB
Ps
TsB
ScC
Ba
TIA
ByC2
LrB
WaB
Tc
BuE
(Joins sheet 11)
(Joins sheet 14)
(Joins sheet 17)
T. 121 N.
R. 28 W.


N
(Joins sheet 118)
R. 26 W.
T. 118 N.
(Joins sheet 119)
(Joins sheet 125)
McGrath School
27
26
25
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35
36
CARVER COUNTY


R. 25 W.
(Joins sheet 97)
N
T. 118 N.
(Joins sheet 116)
(Joins sheet 122)
(Joins sheet 123)
GREAT NORTHERN
FOUNTAIN LAKE
Adickes School
6
5
4
8
9

122

N

(Joins sheet 98)

(Sh 102)

R. 25 W. | R. 24 W.

T. 118 N.

(Joins sheet 121)

(Joins sheet 124)

HENNEPIN COUNTY

Delano

CROW RIVER

SOUTH FORK

GREAT NORTHERN

GRAVEL PIT

GRAVEL PIT

WRIGHT COUNTY, MINNESOTA — SHEET NUMBER 123

123

N

(Joins sheet 121)

R. 25 W.

FOUNTAIN LAKE

T. 118 N.

(Joins sheet 118)

(Joins sheet 124)

(Joins sheet 125)

Hilltop School

St Marys Church

Cedar Lake

124

N

(Joins sheet 122)

R. 25 W.

Delano

ST PETER CEMETERY

DELANO CEMETERY

CROW RIVER

SOUTH FORK

Cedar Lake

15

14

13

22

23

24

T. 118 N.

HENNEPIN COUNTY

(Joins sheet 123)

(Joins sheet 126)

WRIGHT COUNTY, MINNESOTA — SHEET NUMBER 125

125

N

R. 25 W.

(Joins sheet 123)

T. 118 N.

(Joins sheet 120)

(Joins sheet 126)

Hanlin School

CARVER COUNTY

126

N

(Joins sheet 124)

R. 25 W

T. 118 N.

(Joins sheet 125)

Yaney School

Welker School

RIVER

CROW

FORK

SOUTH

RICE LAKE

HENNEPIN COUNTY

CARVER COUNTY


N
R. 28 W.
(Joins sheet 11)
STEARNS COUNTY
MEEKER COUNTY
T. 121 N.
(Joins sheet 14)
(Joins sheet 15)
South Haven
SOO LINE
CLEARWATER RIVER
SCOTT LAKE
JOHN LAKE
18
17
16
19
20
21

14

N

(Joins sheet 12)

R. 28 W.

Lake Augusta

(Joins sheet 13)

(Joins sheet 16)

(Joins sheet 19)

T. 121 N.

15

14

13

22

23

24

GRACE CEMETERY

UNION CEMETERY

SOO LINE

LAKE JOHN

PLEASANT LAKE

N

R. 28 W.

(Joins sheet 13)

T. 121 N.

MEEKER COUNTY

(Joins sheet 16)

(Joins sheet 43)

UNION LAKE

TWIN LAKE

LAKE SYLVIA

GRAVEL PIT

GRAVEL PIT

30 29 28 31 32 33

16

N

(Joins sheet 14)

R. 28 W.

(Joins sheet 15)

(Joins sheet 21)

T. 121 N.

LAKE JOHN

LAKE SYLVIA

GOOSE LAKE

GRAVEL PIT

SOO LINE

27 26 25 34 35 36

(sheet 43) | (Joins sheet 44)

N

R. 27 W.

(Joins sheet 3)

STEARNS COUNTY

BASS LAKE

Bungalow Island

CLEARWATER LAKE

T. 121 N.

(Joins sheet 12)

(Joins sheet 18)

(Joins sheet 19)

(18)

N

R. 27 W.

(Joins sheet 4)

(Joins sheet 17)

(Joins sheet 20)

(Joins sheet 23)

T. 121 N.

SUGAR LAKE

SANDY LAKE

INDIAN LAKE


N
R. 27 W.
T. 121 N.
(Joins sheet 17)
(Joins sheet 14)
(Joins sheet 20)
(Joins sheet 21)
CLEARWATER LAKE
PLEASANT LAKE
Amandale
Cedar Lake
16
17
18
19
20
21
24

(2)

N

R. 27 W.

(Joins sheet 1)

(Joins inset, sheet 3)

(Joins sheet 4)

(Joins sheet 6)

T. 122 N.

FISH LAKE

NIXON LAKE

SHELDON LAKE

Fish Creek

15 14 13 22 23 24

N

R. 27 W.

T. 121 N.

(Joins sheet 18)

(Joins sheet 19)

(Joins sheet 22)

(Joins sheet 25)

CEDAR LAKE

MINK LAKE

15 14 13 22 23 24

N

R. 27 W.

(Joins sheet 19)

T. 121 N.

(Joins sheet 16)

(Joins sheet 22)

(44) | (Joins sheet 49)

Annandale

Pleasant Lake

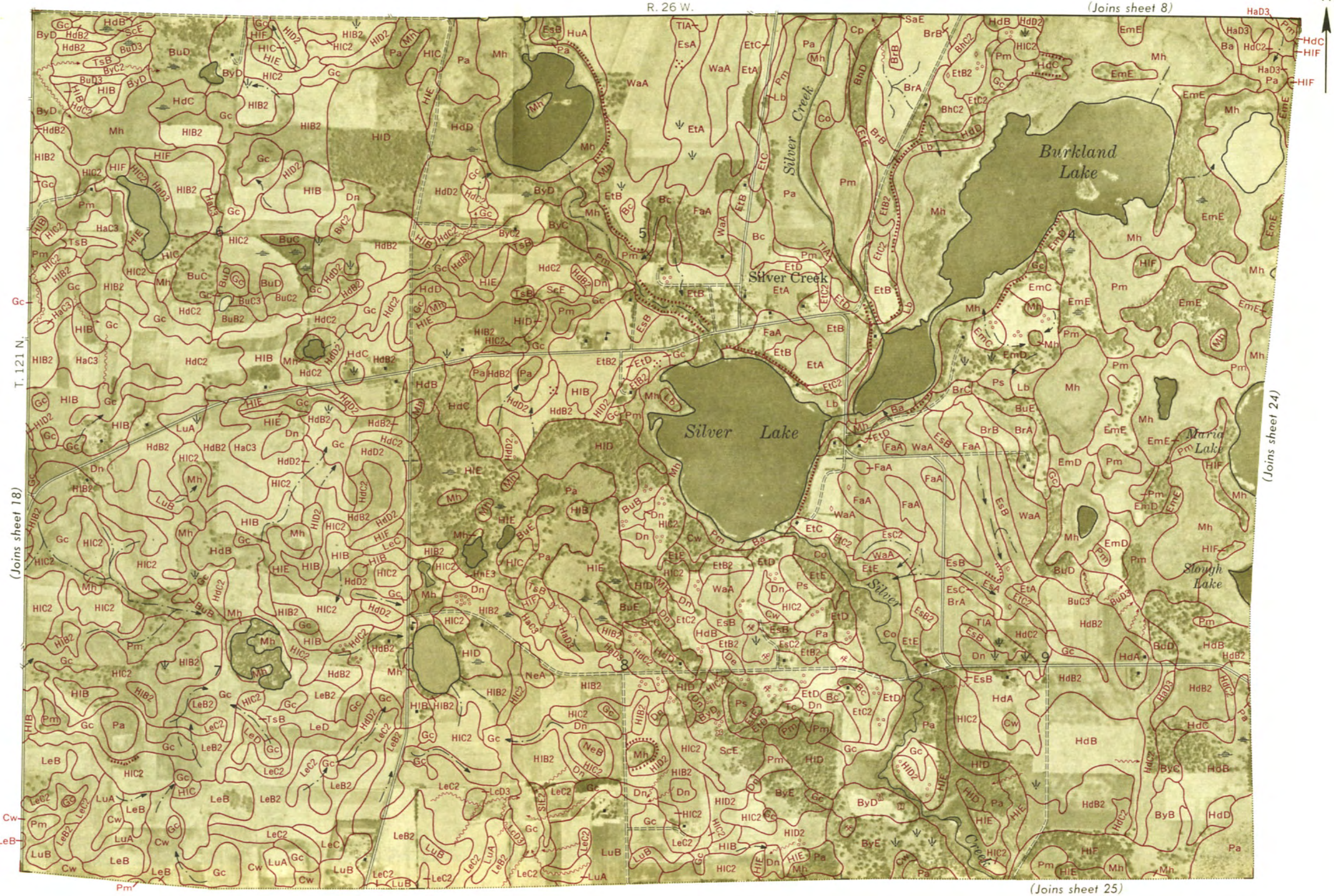
SOO LINE

30 29 28 31 32 33

HIB2

22


N
(Joins sheet 20)
R. 27 W.
T. 121 N.
CEDAR LAKE
Somers Lake
Mink Lake
27
26
25
34
35
36
(Joins sheet 21)
(Joins sheet 27)
(49)
(Joins sheet 50)
55
SOO LINE


N
R. 26 W.
T. 121 N.
(Joins sheet 8)
(Joins sheet 18)
(Joins sheet 24)
(Joins sheet 25)
Burkland Lake
Silver Lake
Silver Creek
Maria Lake
Slough Lake
Silver Creek
5
6
4
8
9

N

(Joins sheet 9)

R. 26 W.

T. 121 N.

(Joins sheet 23)

(Joins sheet 29)

(Joins sheet 26)

West Lake

Maria Lake

Slough Lake

IDA LAKE

1 2 3 10 11 12


R. 26 W.
(Joins sheet 23)
N
T. 121 N.
(Joins sheet 20)
(Joins sheet 26)
(Joins sheet 27)
MILLSTONE LAKE
LAKEVIEW CEMETERY
Silver Creek Church
Silver Creek
17
18
19
20
21
16

N

(Joins sheet 24)

R. 26 W.

(Joins sheet 25)

T. 121 N.

(Joins sheet 31)

(Joins sheet 28)

EAGLE LAKE

Parvin Lake

Middle Lake

Slough Lake

Twin Lakes

15 14 13 22 23 24


N
(Joins sheet 25)
R. 26 W.
T. 121 N.
LAKE MARY
MAPLE LAKE
Maple Lake
Silver Creek
30
29
28
31
32
33
(Joins sheet 22)
(Joins sheet 28)
(50)
(Joins sheet 55)

28

N

R. 26 W.

(Joins sheet 26)

(Joins sheet 27)

(Joins sheet 33)

(55) | (Joins sheet 56)

T. 121 N.

East Maple Lake School

ST TIMOTHY CEMETERY

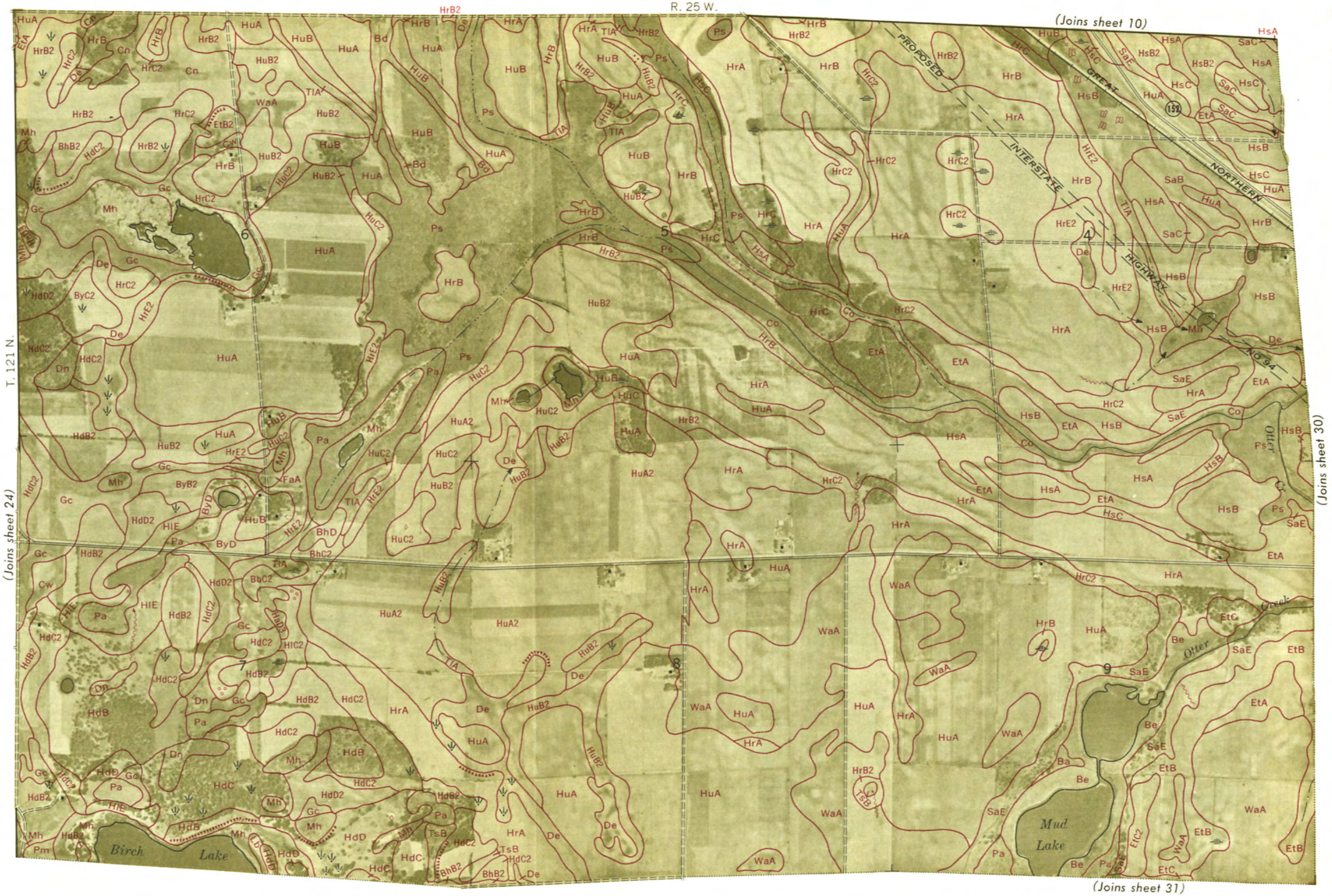
MAPLE LAKE

Black Lake

Black Lake

27 26 25

34 35 36


R. 25 W.
T. 121 N.
N
(Joins sheet 10)
(Joins sheet 24)
(Joins sheet 30)
(Joins sheet 31)
PROPOSED
INTERSTATE
GREAT
NORTHERN
HIGHWAY
NO 94
152
Birch
Lake
Mud
Lake
Otter
Creek
5
6
7
8
9
4

WRIGHT COUNTY, MINNESOTA — SHEET NUMBER 3

3

N

R. 27 W.

(Joins lower left)

(Joins upper right)

(Joins sheet 2)

(Joins sheet 4)

(Joins sheet 17)

T. 122 N.

CLEARWATER RIVER

STEARNS COUNTY

WIEGAND LAKE

GRASS LAKE

BASS LAKE

GRAVEL PIT

16

21

28

29

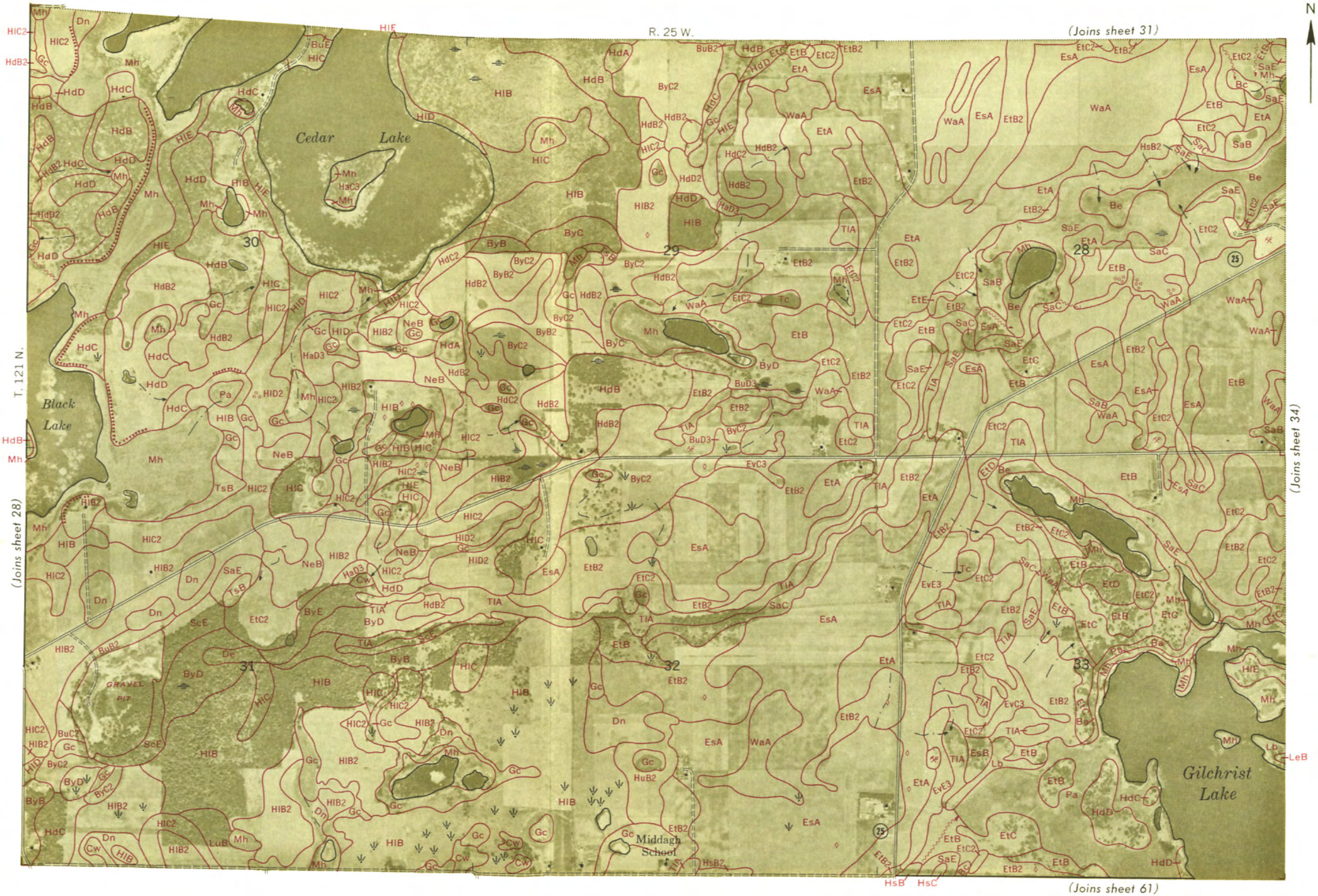
32

33


N
(Joins sheet 10)
SHERBURNE COUNTY
MISSISSIPPI RIVER
Monticello
GREAT NORTHERN
PROPOSED INTERSTATE HIGHWAY NO 94
INTERCHANGE
RIVERSIDE CEMETERY
HILLSIDE CEMETERY
ST HENRYS CEMETERY
DUMP
Otter Creek
T. 121 N.
R. 25 W.
(Joins sheet 29)
(Joins sheet 32)
(35)
10
11
12
SaC
HsA
SaE
Cp
Al
HsB2
HsB
HsC
EtB
HrB
HuA
HrA
De
Ps
Co
Mh
WaA
EtA
SaB
EvC3
TIA
FaB
EsA
EtB2
EtC2
TeA
BrB


N
R. 25 W.
T. 121 N.
(Joins sheet 29)
(Joins sheet 26)
(Joins sheet 32)
(Joins sheet 33)
Birch Lake
Bertram Lake
Long Lake
Mud Lake
North Lake
Twin Lakes
Cedar Lake
Slough Lake
18
17
16
19
20
21


N
(Joins sheet 30)
R. 25 W.
PROPOSED INTERSTATE HIGHWAY NO 94
GREAT NORTHERN
HELM CEMETERY
T. 121 N.
(Joins sheet 31)
(Joins sheet 35)
(Joins sheet 34)
15
14
13
22
23
24
25
152


N
R. 25 W.
T. 121 N.
(Joins sheet 31)
(Joins sheet 28)
(Joins sheet 34)
(Joins sheet 61)
Cedar Lake
Black Lake
Gilchrist Lake
Middagh School
GRAVEL PIT
30
29
28
31
32
33
25


N
(Joins sheet 32)
R. 25 W.
T. 121 N.
(Joins sheet 33)
(Joins sheet 37)
(Joins sheet 62)
Slough Lake
Paradise Lake
Gilchrist Lake
PELICAN LAKE
Pelican L
25
26
27
34
35
36


MISSISSIPPI RIVER
SHERBURNE COUNTY
SHERBURNE COUNTY
N
(Joins sheet 32) | (30)
T. 121 N.
R. 24 W.
(Joins sheet 36)
(Joins sheet 37)
GREAT NORTHERN PROPOSED INTERSTATE HIGHWAY 94
GREAT NORTHERN
8
9
16
17
18
19
20
21
152
SaE
EtA
HIB
HIC2
Du
HIB
HIC2
Du

N

SHERBURNE COUNTY

MISSISSIPPI RIVER

SHERBURNE COUNTY

10 11 12 13 14 15 22 23 24

(Joins sheet 35)

(Joins sheet 39)

(Joins sheet 38)

T. 121 N.

R. 24 W.


R. 24 W.
T. 121 N.
N
(Joins sheet 35)
(Joins sheet 34)
(Joins sheet 38)
(Joins sheet 67)
PROPOSED INTERSTATE HIGHWAY NO. 94
GREAT NORTHERN
PELICAN LAKE
Pelican L
30
29
28
31
32
33
152

38

N

(Joins sheet 36)

R. 24 W.

T. 121 N.

(Joins sheet 37)

(Joins sheet 41)

(Joins sheet 68)

PROPOSED GREAT NORTHERN INTERSTATE HIGHWAY NO 94

INTERCHANGE

INTERCHANGE

Albertville

Mud Lake

School Lake

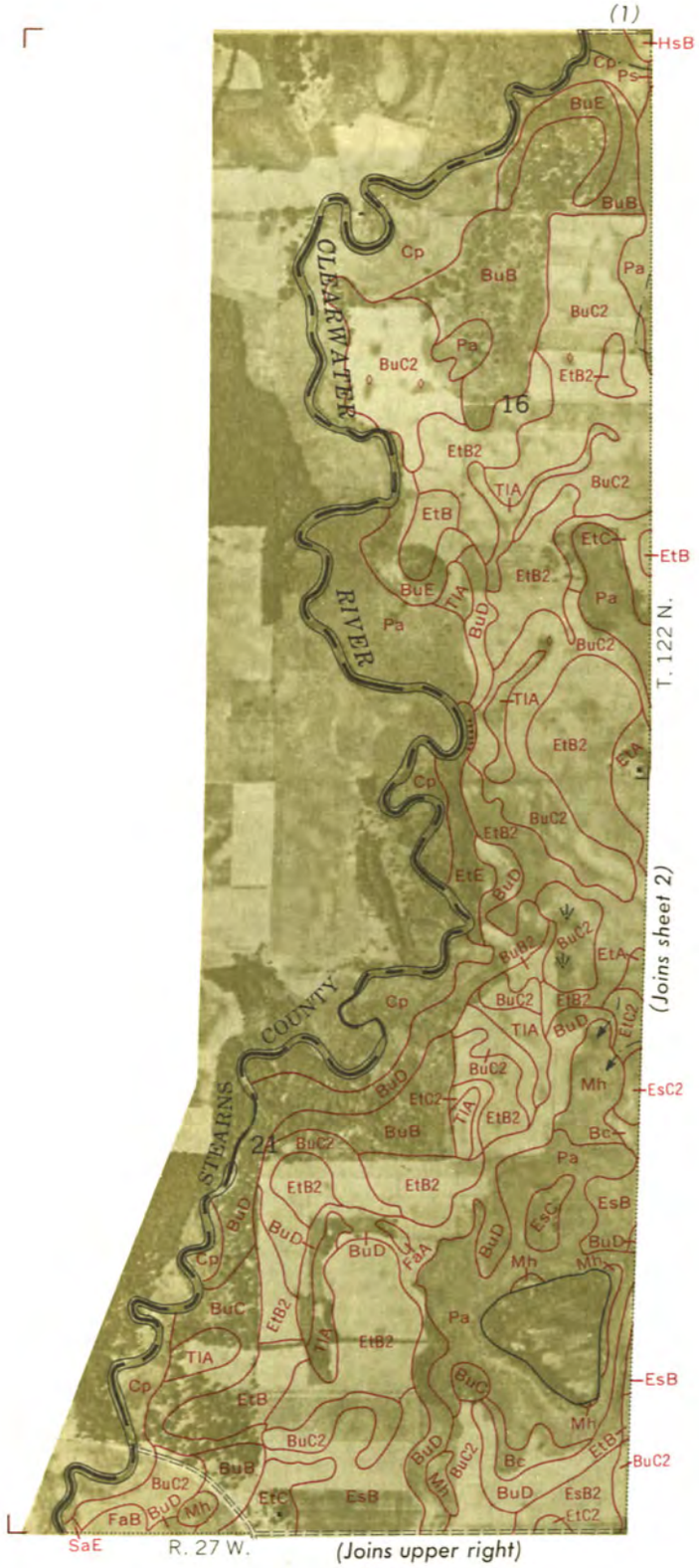
27 26 25 34 35 36

HIB2 HIB HIC2 HIC HID2 HdB2 HdC2 HIE Du Gc Cw Mh NeA NeB TsB ScE ByD Pm Pa Ba HdB


SHERBURNE COUNTY
MISSISSIPPI RIVER
SHERBURNE COUNTY
N
Otsego
GRAVEL PIT
18
17
16
19
20
21
T. 121 N.
R. 23 W.
(Joins sheet 36)
(Joins sheet 40)
(Joins sheet 41)

WRIGHT COUNTY, MINNESOTA — SHEET NUMBER 3

3



N

(Joins sheet 2)

R. 27 W.

(Joins sheet 3)

(Joins sheet 8)

T. 122 N.

(Joins sheet 18)

Cornell Lake

SUGAR LAKE

27 26 25 34 35 36

40

N

T. 121 N.

(Joins sheet 39)

SHERBURNE COUNTY

MISSISSIPPI RIVER

SHERBURNE COUNTY

10 15 14 22 23

(101)

(Joins sheet 42)

R. 23 W.


R. 23 W.
(Joins sheet 39)
T. 121 N.
(Joins sheet 38)
(Joins sheet 42)
(Joins sheet 73)
(74)
N
28
29
30
31
32
33

N

(Joins sheet 40)

(Joins sheet 41)

(Joins sheet 74)

T. 121 N.

SHERBURNE CO. — MISSISSIPPI — RIVER — SHERBURNE COUNTY

HENNEPIN COUNTY

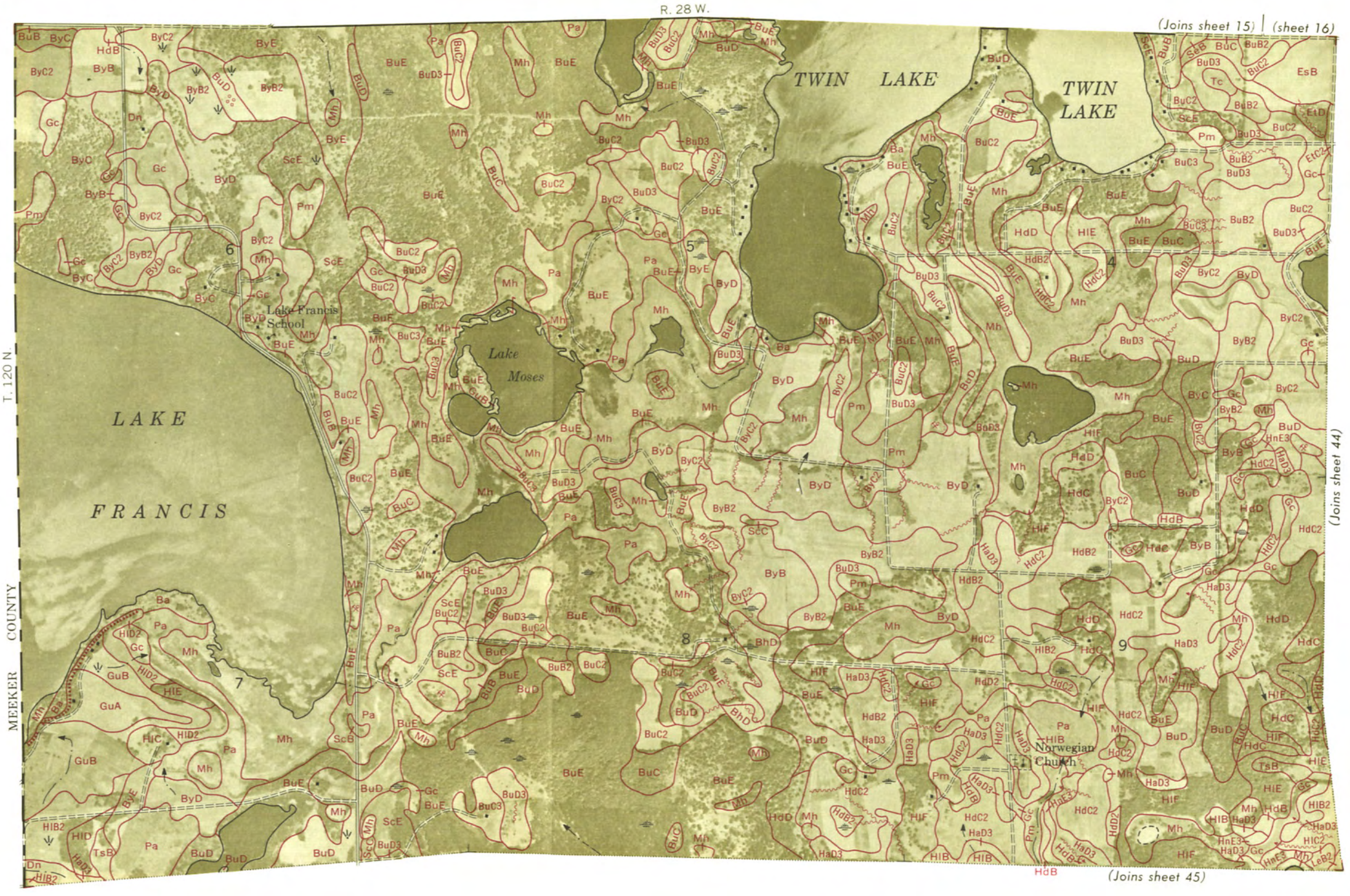
Rice Lake

Dayton

27 26 25 34 35 36 31

101

R. 23 W. | R. 22 W


N
R. 28 W.
(Joins sheet 15)
(sheet 16)
TWIN LAKE
TWIN LAKE
Lake Francis School
Lake Moses
LAKE FRANCIS
Norwegian Church
T. 120 N.
MEEKER COUNTY
(Joins sheet 44)
(Joins sheet 45)


N
R. 28 W.
T. 120 N.
Goose Lake
FRENCH LAKE
(Joins sheet 43)
(Joins sheet 46)
(Joins sheet 49)
(Joins sheet 16)
(21)


N
R. 28 W.
(Joins sheet 43)
T. 120 N.
MEEKER COUNTY
(Joins sheet 46)
(Joins sheet 47)
Grace Church
Lee School
CROW RIVER
NORTH FORK
French Creek
16
17
18
19
20
21


N
(Joins sheet 44)
R. 28 W.
FRENCH LAKE
Creek
French Lake
Dans Lake
Gunnary School
ST IGNATIUS CEMETERY
West Albion
NORTH FORK CROW RIVER
OUR SAVIOUR CEMETERY
NATIONAL CEMETERY
French Lake Church
15
14
13
22
23
24
T. 120 N.
(Joins sheet 45)
(Joins sheet 48)
(Joins sheet 51)

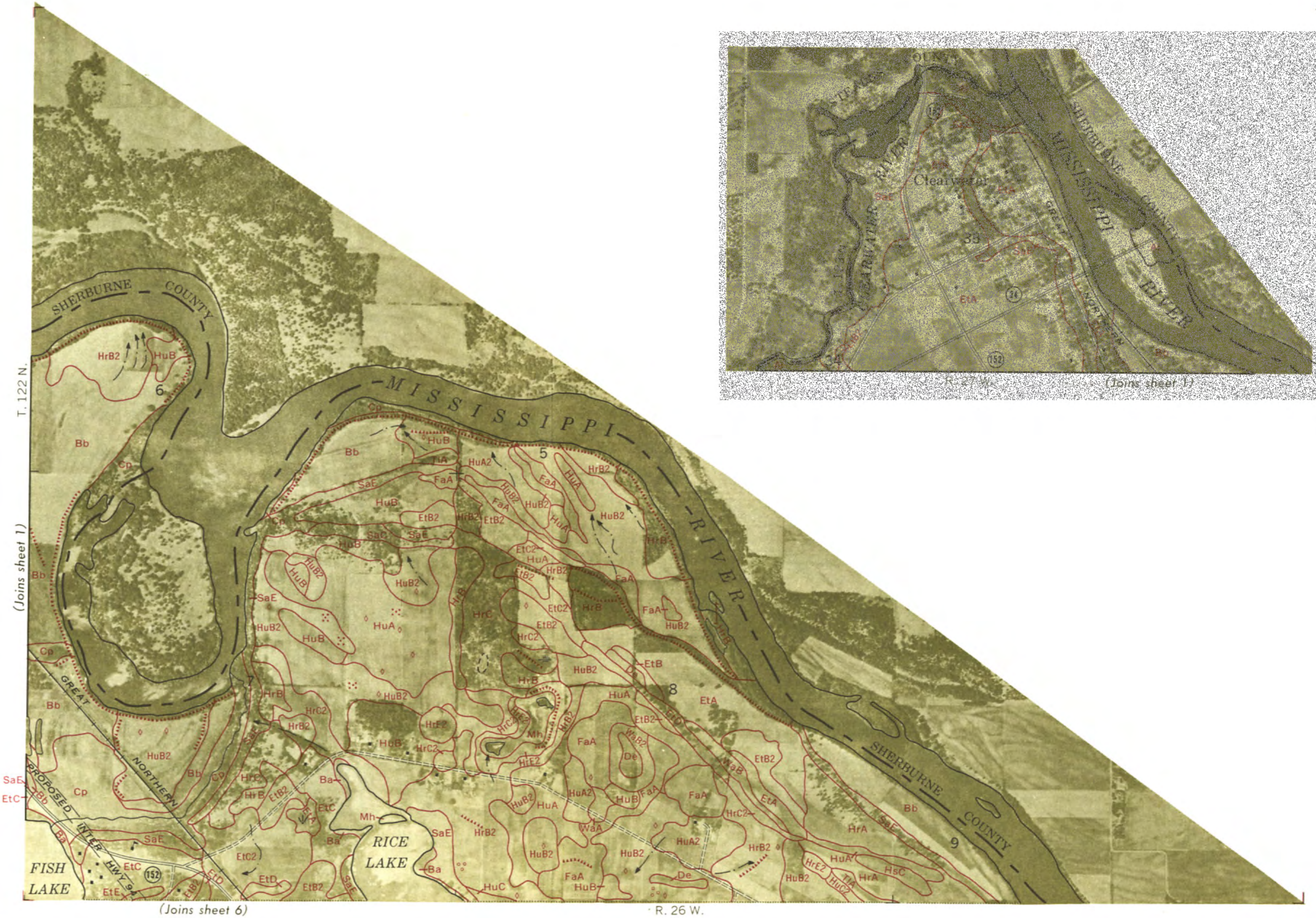

R. 28 W.
T. 120 N.
MEEKER COUNTY
Happy Corner School
French Lake Church
CROW RIVER
NORTH FORK
Knapp
29
30
31
32
33
28
(Joins sheet 45)
(Joins sheet 48)
(Joins sheet 75)
N

48


N
(Joins sheet 46)
R. 28 W.
T. 120 N.
(Joins sheet 47)
(Joins sheet 53)
(Joins sheet 76)
CROW RIVER
NORTH FORK CROW RIVER
NORTH FORK CROW RIVER
RIVERSIDE CEMETERY
Crow River Church
Birch Lake School
Slough Lake
27
26
25
34
35
36


N
R. 27 W.
(Joins sheet 21) | (22)
T. 120 N.
(Joins sheet 44)
(Joins sheet 50)
(Joins sheet 51)
Willima Lake
Henry Lake
Edwards Lake
SWART LAKE
WATTS LAKE
ALBION LAKE

N


CLEARWATER
RIVER
Clearwater
MISSISSIPPI
RIVER
SHERBURNE
COUNTY
GREAT
NORTHERN
35
34
152
R. 27 W.
(Joins sheet 1)
SHERBURNE
COUNTY
MISSISSIPPI
RIVER
T. 122 N.
(Joins sheet 1)
GREAT
NORTHERN
PROPOSED
INTER
HWY 94
152
RICE
LAKE
FISH
LAKE
6
5
7
8
9
(Joins sheet 6)
R. 26 W.


N
R. 27 W.
(Joins sheet 22) (27)
SWART
WATTS
LAKE
ALBION
LAKE
Henshaw
Lake
1500 LINE
(Joins sheet 49)
(Joins sheet 55)
T. 120 N.
(Joins sheet 52)
1
2
3
10
11
12

WRIGHT COUNTY, MINNESOTA — SHEET NUMBER 51

N

(Joins sheet 50)

R. 27 W.

(Joins sheet 51)

T. 120 N.

(Joins sheet 57)

HENSHAW LAKE

White Lake

Little Rock Lake

Albion Center School

15 14 13

22 23 24

(Joins sheet 54)

WRIGHT COUNTY, MINNESOTA — SHEET NUMBER 53

53

N

R. 27 W.

(Joins sheet 51)

GRANITE LAKE

Albion Center

Mt Vernon Church

Albion Church

Camp Lake

30 29 28 31 32 33

T. 120 N.

(Joins sheet 48)

(Joins sheet 54)

(Joins sheet 81)


N
(Joins sheet 52)
R. 27 W.
T. 120 N.
Albion Center
Fitzpatrick School
Little Rock Lake
ROCK LAKE
EVANGELICAL CEMETERY
Bethlehem School
Wolfe School
27
26
25
34
35
36
(Joins sheet 53)
(Joins sheet 59)
(Joins sheet 82)

N

R. 26 W.

T. 120 N.

MAPLE LAKE

RAMSEY LAKE

Maple Lake

NEW ST TIMOTHY CEMETERY

SOO LINE

Mill Creek

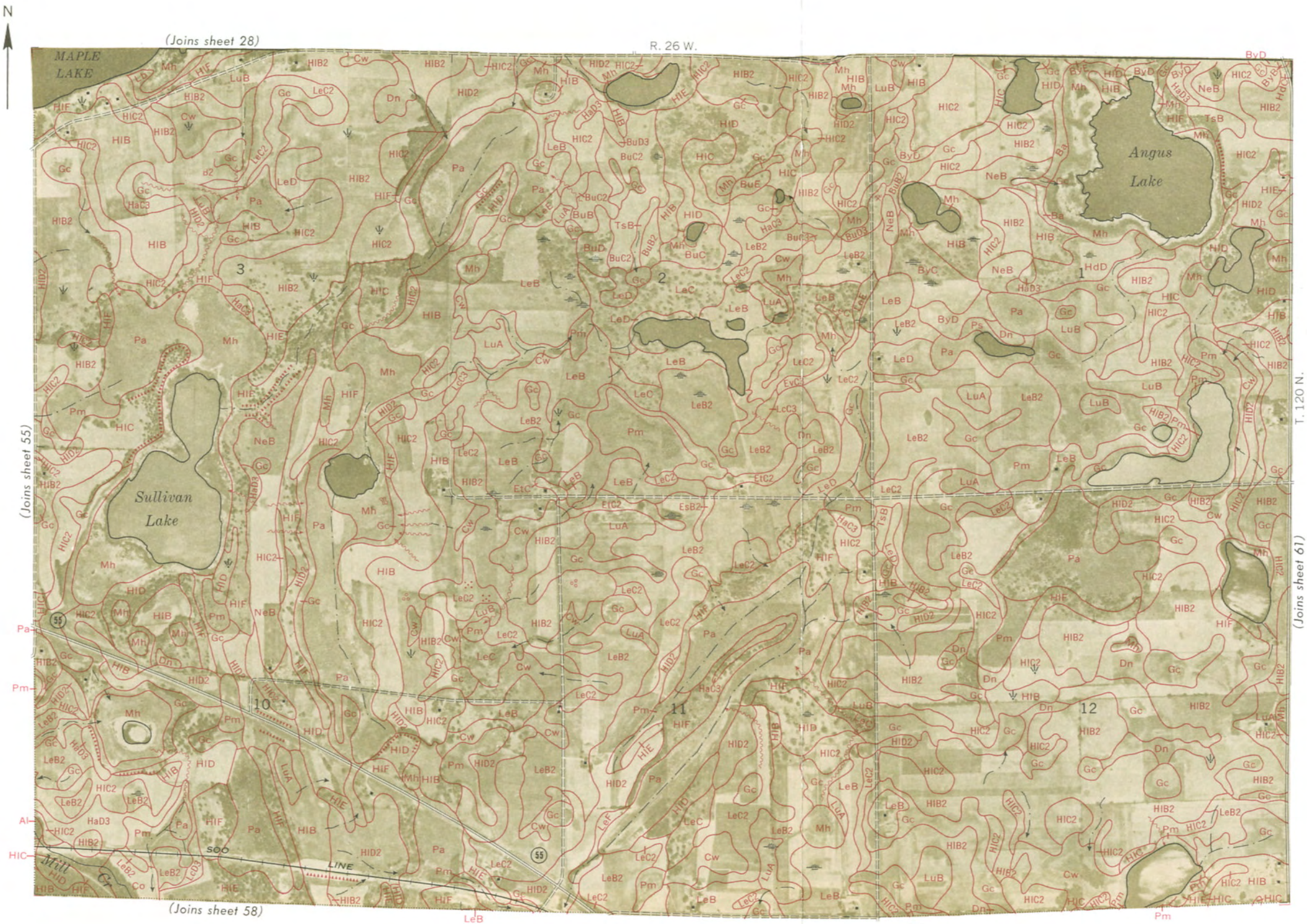
(Joins sheet 27) | (28)

(Joins sheet 50)

(Joins sheet 56)

(Joins sheet 57)

56


N
(Joins sheet 28)
R. 26 W.
MAPLE LAKE
Angus Lake
Sullivan Lake
(Joins sheet 55)
(Joins sheet 61)
T. 120 N.
(Joins sheet 58)
SOO LINE
Mill Cr.
3
2
1
10
11
12


R. 26 W.
(Joins sheet 25)
N
T. 120 N.
RAMSEY LAKE
Mary Lake
Pouman Lake
Mill Creek
ST CHARLES CEMETERY
18
17
16
19
20
21
(Joins sheet 52)
(Joins sheet 58)
(Joins sheet 59)


N
(Joins sheet 56)
R. 26 W.
T. 120 N.
(Joins sheet 57)
(Joins sheet 63)
(Joins sheet 60)
LIGHT FOOT LAKE
TWIN LAKES
VARNER LAKE
Albert Lake
Mill Creek
Creek
SOO LINE
13
14
15
22
23
24

WRIGHT COUNTY, MINNESOTA — SHEET NUMBER 59

N

R. 26 W.

(Joins sheet 57)

T. 120 N.

(Joins sheet 54)

(Joins sheet 60)

(Joins sheet 87)

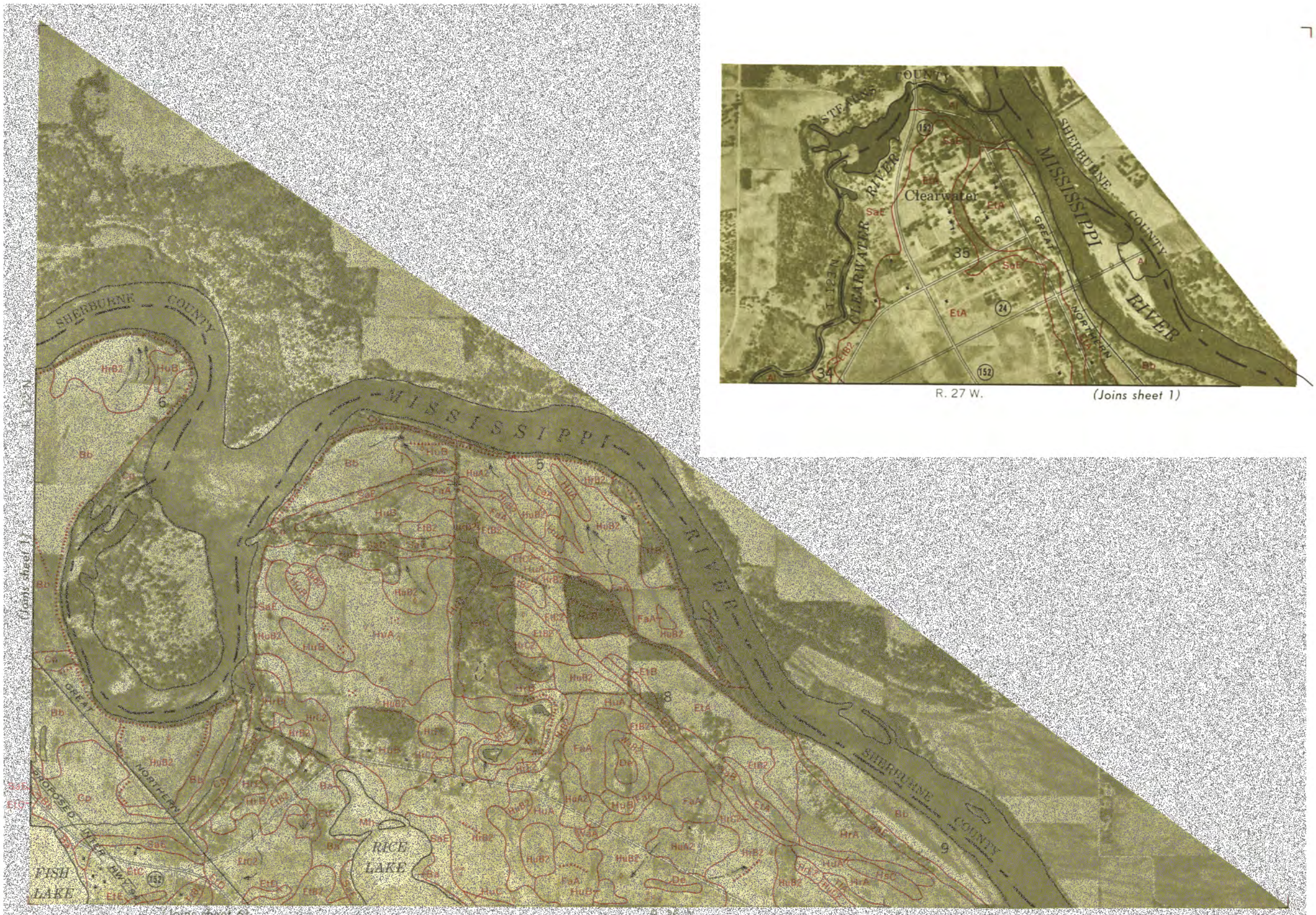
ROCK LAKE

ABBIE LAKE

Rassett

30 29 28 31 32 33

N


SHERBURNE COUNTY
MISSISSIPPI RIVER
CLEARWATER RIVER
Clearwater
GREAT NORTHERN
PROPOSED TH 24
FISH LAKE
RICE LAKE
HrB2
HuB
HuB2
HuA2
FaA
SaE
EtA
EtB2
EtC2
Bb
Cp
Ba
De
HsC
5
6
7
8
9
24
35
34
152
R. 27 W.
R. 26 W.
(Joins sheet 1)
(Joins sheet 6)

6

N


(Joins sheet 5)
R. 26 W.
FISH LAKE
RICE LAKE
SHERBURNE
MISSISSIPPI
COUNTY
RIVER
PROPOSED
GREAT NORTHERN
INTERSTATE
HIGHWAY
NO. 94
INTERCHANGE
HIGHLAND CEMETERY
Hasty
LOCKE LAKE
Silver Creek
16
17
18
19
20
21
T. 122 N.
(Joins sheet 2)
(Joins sheet 7)
(Joins sheet 8)


N
(Joins sheet 58)
R. 26 W.
T. 120 N.
(Joins sheet 59)
(Joins sheet 65)
(Joins sheet 88)
Albert Lake
ABBIE LAKE
Birch Lake
Mink Creek
BUFFALO LAKE
Mink Lake
ST FRANCIS CEMETERY
25
26
27
34
35
36

N

R. 25 W.

T. 120 N.

Constance Lake

Gilchrist Lake

(Joins sheet 33)

(Joins sheet 56)

(Joins sheet 62)

(Joins sheet 63)

62

N

(Joins sheet 34)

R. 25 W.

T. 120 N.

(Joins sheet 61)

(Joins sheet 67)

(Joins sheet 64)

Gilchrist Lake

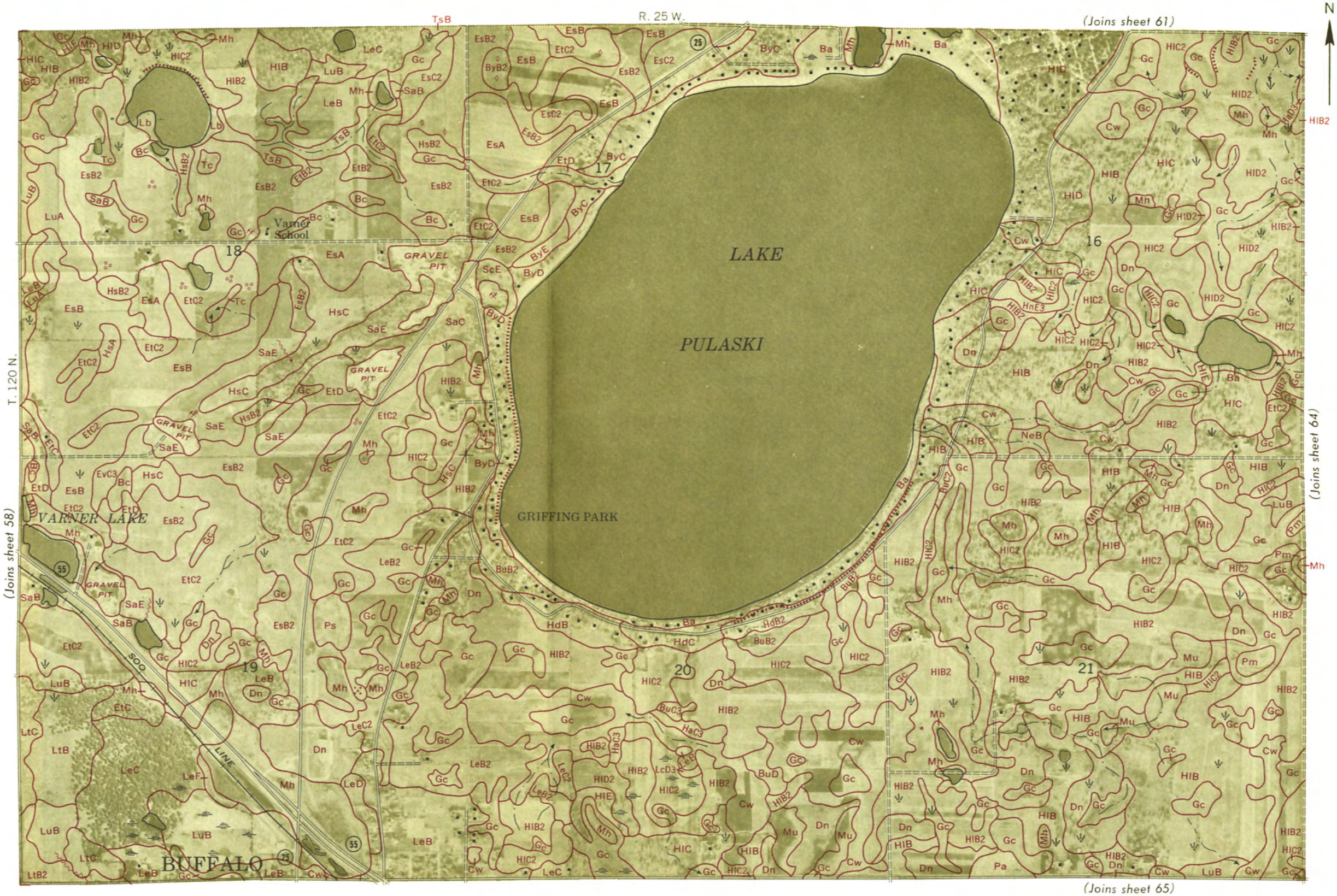
PELICAN LAKE

PELICAN LAKE

Elletson School

PELICAN LAKE CEMETERY

1 2 3 10 11 12


R. 25 W.
T. 120 N.
N
(Joins sheet 61)
(Joins sheet 58)
(Joins sheet 64)
(Joins sheet 65)
LAKE
PULASKI
GRIFFING PARK
VARNER LAKE
BUFFALO
Varner School
GRAVEL PIT
SOO LINE
17
18
19
20
16
21
25
55

64

N

R. 25 W.

T. 120 N.

(Joins sheet 62)

(Joins sheet 63)

(Joins sheet 69)

(Joins sheet 66)

PELICAN LAKE

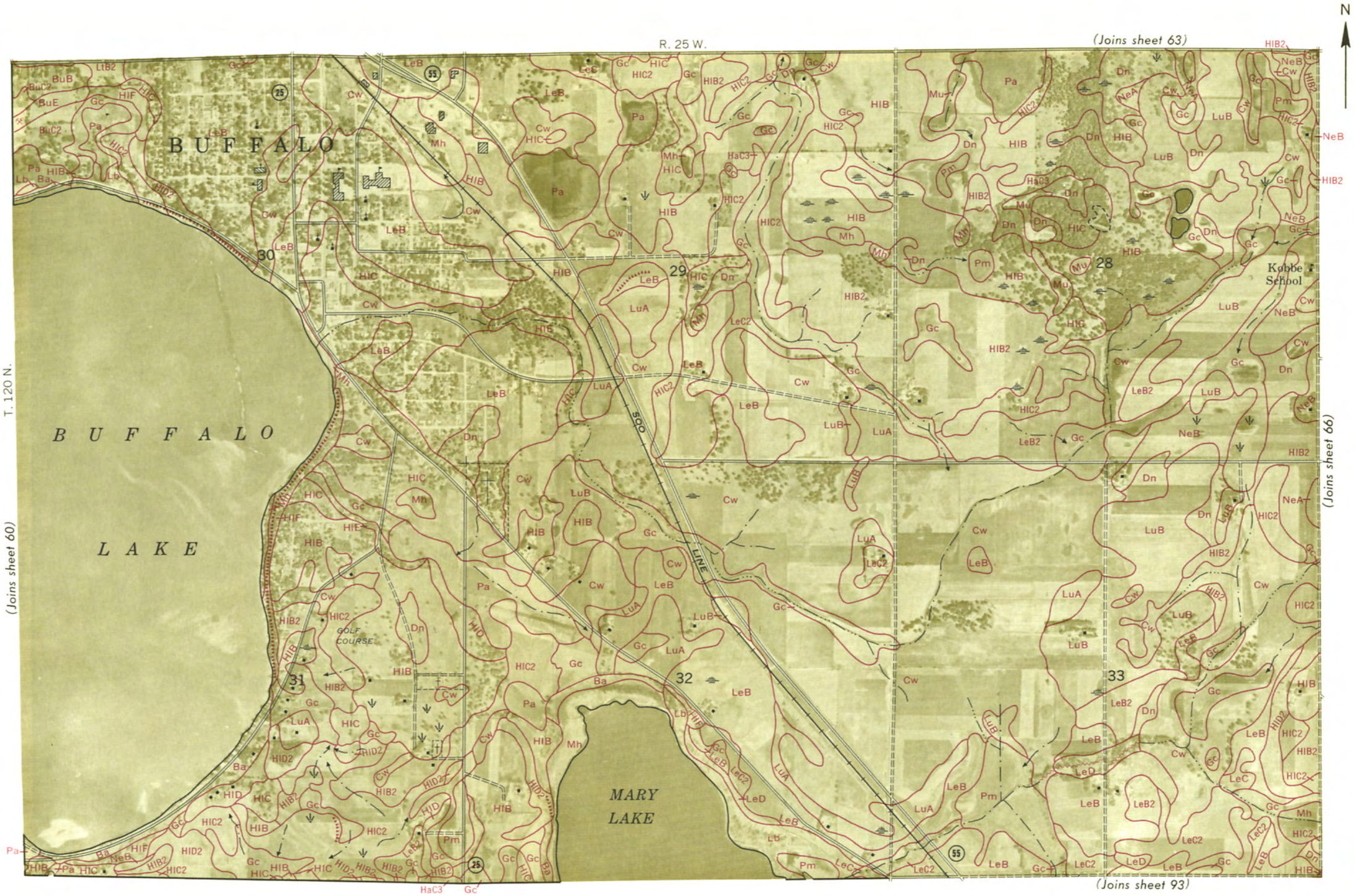
Pelican Lake School

ST MARKS CEMETERY

Washington Lake

Schmidt Lake

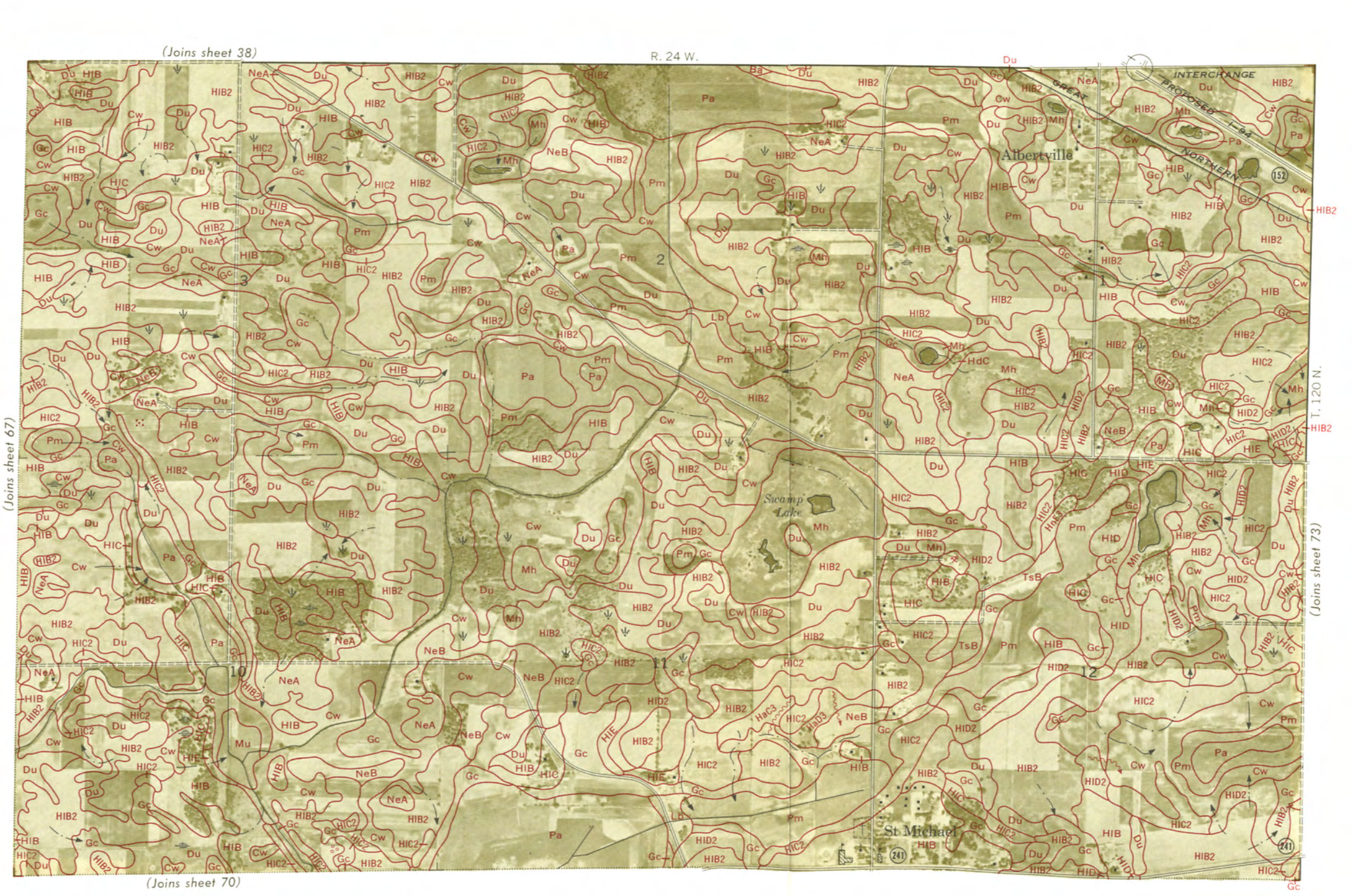
13 14 15 22 23 24


N
R. 25 W.
(Joins sheet 63)
T. 120 N.
(Joins sheet 60)
(Joins sheet 66)
(Joins sheet 93)
BUFFALO
BUFFALO LAKE
MARY LAKE
Kobbe School
GOLF COURSE
590
LINE
30
29
28
31
32
33

N


(Joins sheet 64)
R. 25 W.
Schmidt School
Pelican Lake Church
Schmidt Lake
Green Mountain Lake
Moore Lake
27
26
25
34
35
36
T. 120 N.
(Joins sheet 65)
(Joins sheet 71)
(Joins sheet 94)


N
R. 24 W.
T. 120 N.
(Joins sheet 37)
(Joins sheet 62)
(Joins sheet 68)
(Joins sheet 69)
PELICAN LAKE
4
5
6
7
8
9


N
(Joins sheet 38)
R. 24 W.
(Joins sheet 67)
T. 120 N.
(Joins sheet 73)
(Joins sheet 70)
Albertville
St Michael
Swamp Lake
INTERCHANGE
PROPOSED I-94
GREAT NORTHERN
152
241
2
3
10
11
12

N

R. 24 W.

(Joins sheet 67)

T. 120 N.

(Joins sheet 64)

(Joins sheet 70)

(Joins sheet 71)

PELICAN LAKE

Lake School

Elliott School

Uhl Lake

17 16 18 19 20 21

N

SHERBURNE COUNTY

MISSISSIPPI RIVER

SHERBURNE COUNTY

Silver Creek

Locke Lake

Enfield

PROPOSED GREAT NORTHERN INTERSTATE HIGHWAY NO 94

T. 122 N.

15 14 13 22 23 24 19

(Joins sheet 6)

(Joins sheet 9)

R. 26 W. | R. 25 W. (sheet 10)

N

(Joins sheet 68)

R. 24 W.

(Joins sheet 73)

T. 120 N.

(Joins sheet 69)

(Joins sheet 72)

St Michael

ST MICHAEL CEMETERY

HENNEPIN COUNTY

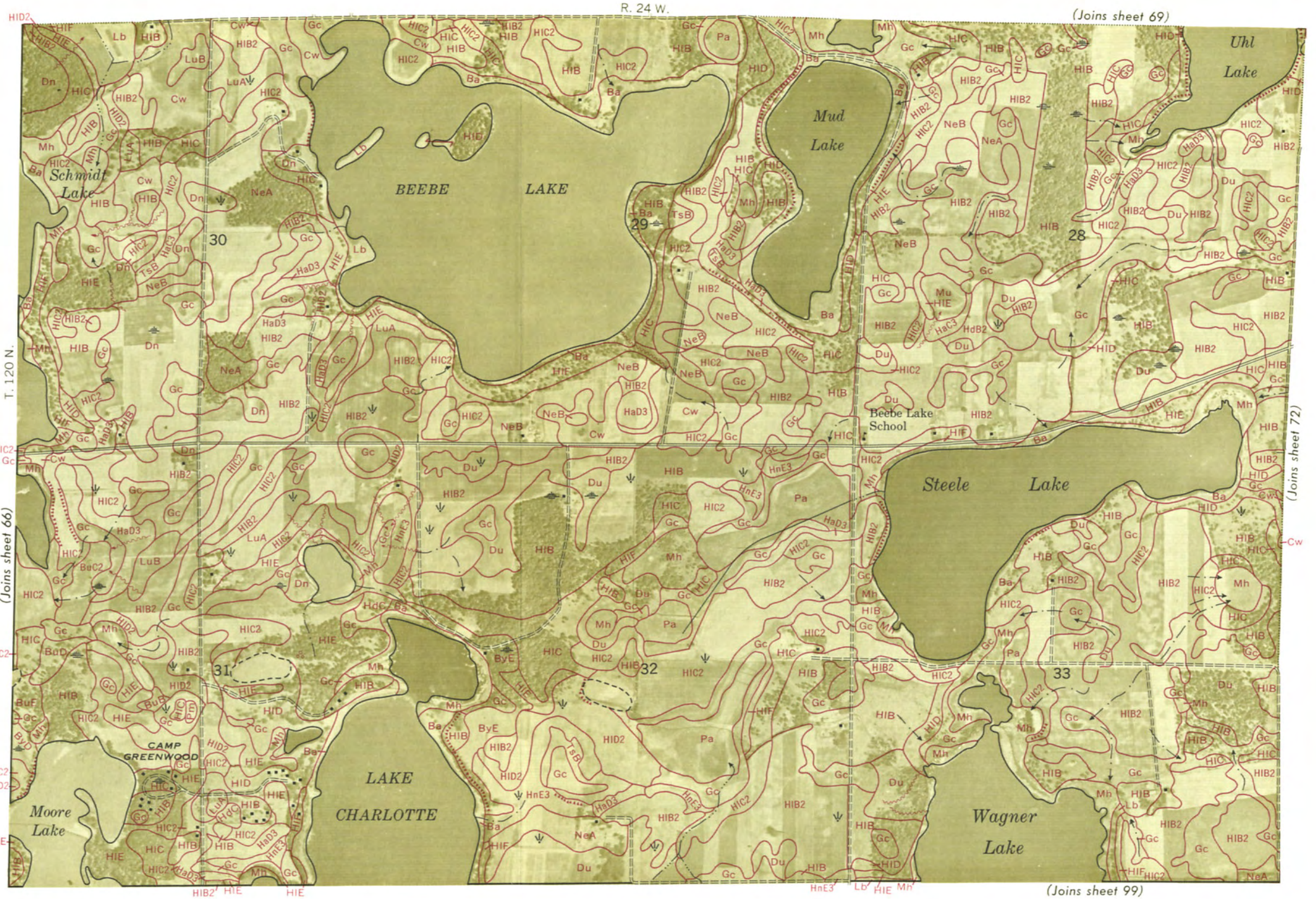
CROW RIVER

Gonz Lake

Uhl Lake

15 14 13

22 23 24


N
R. 24 W.
T. 120 N.
(Joins sheet 69)
(Joins sheet 66)
(Joins sheet 72)
(Joins sheet 99)
BEEBE LAKE
Mud Lake
Uhl Lake
Schmidt Lake
Steele Lake
Wagner Lake
LAKE CHARLOTTE
Moore Lake
CAMP GREENWOOD
Beebe Lake School
30
29
28
31
32
33

N

(Joins sheet 70)

R. 24 W. | R. 23 W.

T. 120 N.

Lake Wilhelm

Zion Church

Hanover

GRAVEL PIT

HENNEPIN COUNTY

CROW RIVER

(Joins sheet 71)

(Joins sheet 100)

R. 23 W.

(Joins sheet 41)

N

T. 120 N.

(Joins sheet 74)

(Joins sheet 70) | (Joins sheet 68)

ST. ALBERT CEMETERY

PROPOSED INTERSTATE GREAT NORTHERN HIGHWAY 94

Foster Lake

GRAVEL PIT

CROW RIVER

HENNEPIN COUNTY

TS2 · 241 · 152


N
(41)
(Joins sheet 42)
R. 23 W.
R. 22 W.
T. 120 N.
(Joins sheet 73)
Lake
Foster
HENNEPIN COUNTY
CROW RIVER
CROW RIVER
1
2
3
10

N

R. 28 W.

(Joins sheet 47)

T. 119 N.

MEEKER COUNTY

Knapp

Knapp School

Swan Lake

Finnish Church

Temperance School

(Joins sheet 76)

(Joins sheet 77)


N
(Joins sheet 48)
R. 28 W.
Slough Lake
NORTH FORK CROW RIVER
T. 119 N.
(Joins sheet 75)
(Joins sheet 81)
(Joins sheet 78)
GRAVEL PIT

N

R. 28 W.

(Joins sheet 75)

T. 119 N.

MEEKER COUNTY

Ojampera School

(Joins sheet 78)

(Joins sheet 79)

78


N
(Joins sheet 76)
R. 28 W.
T. 119 N.
(Joins sheet 77)
(Joins sheet 83)
(Joins sheet 80)
COKATO
LAKE
COKATO CEMETERY
Sucker Creek
13
14
15
22
23
24


N
R. 28 W.
T. 119 N.
MEEKER COUNTY
(Joins sheet 77)
(Joins sheet 80)
(Joins sheet 103)
Brooks Lake
Dahlgren Slough
Beaver Dam Lake
Beaver Dam School
GREAT NORTHERN
Cokato
Collinwood Cr
Sucker Creek
29
30
31
32
33
28

8

N

R. 26 W.

T. 122 N.

(Joins sheet 6)

(Joins sheet 4)

(Joins sheet 9)

(Joins sheet 23)

LOCKE LAKE

TWIN LAKE

EMBER LAKE

LIMESTONE LAKE

Silver Creek

Carter School

GRAVEL PIT

29 28 30 31 32 33

N

(Joins sheet 78)

R. 28 W.

T. 119 N.

(Joins sheet 79)

(Joins sheet 85)

(Joins sheet 104)

Sucker Creek

GREAT NORTHERN

SEWAGE DISPOSAL LAGOON

WATSON CEMETERY

SMITH LAKE

Cokato

25 26 27 34 35 36

N

R. 27 W.

(Joins sheet 53)

T. 119 N.

(Joins sheet 76)

(Joins sheet 82)

(Joins sheet 83)

Maple Grove School

Albright

Sylvan Church

CROW RIVER

NORTH FORK

(82)

N

R. 27 W.

T. 119 N

(Joins sheet 54)

(Joins sheet 81)

(Joins sheet 87)

(Joins sheet 84)

WOLFE LAKE

Middleville Church

Highland

NORTH FORK CROW RIVER

CROW RIVER

NORTH FORK CROW RIVER

GRAVEL PIT

10

11

12

N

R. 27 W.

T. 119 N.

(Joins sheet 81)

(Joins sheet 78)

(Joins sheet 84)

(Joins sheet 85)

Malquist School

BETHEL CEMETERY

NORTH FK. CROW RIVER

CROW RIVER

18 17 16

19 20 21

84

N


(Joins sheet 82)
R. 27 W.
Highland
Taylor Lake
13
14
15
22
23
24
T. 119 N.
(Joins sheet 83)
(Joins sheet 89)
(Joins sheet 86)

WRIGHT COUNTY, MINNESOTA — SHEET NUMBER 85

85

N

R. 27 W

(Joins sheet 83)

T. 119 N.

(Joins sheet 80)

(Joins sheet 86)

(Joins sheet 109)

Smith Lake

SMITH LAKE

Spring Lake

HOWARD LAKE

GREAT NORTHERN

FAIRGROUNDS

30 29 28 31 32 33

N

(Joins sheet 84)

R. 27 W.

(Joins sheet 85)

(Joins sheet 91)

T. 119 N.

(Joins sheet 110)

Doerfler Lake

School Section Lake

North Howard School

HOWARD LAKE

GREAT NORTHERN

27 26 25 34 35 36


N
R. 26 W.
T. 119 N.
(Joins sheet 59)
(Joins sheet 82)
(Joins sheet 88)
(Joins sheet 89)
FORK
CROW
RIVER
NORTH
GRAVEL PIT
McKinley School
5
6
7
8
9
4

88

N


(Joins sheet 60)
R. 26 W.
Birch Lake
Deer Lake
BUFFALO LAKE
Mink Lake
Tamarack Lake
Persian School
Carlson School
MARYSVILLE CEMETERY
GRAVEL PIT
(Joins sheet 87)
(Joins sheet 90)
(Joins sheet 93)
T. 119 N.
1
2
3
10
11
12

N

R. 26 W.

(Joins sheet 87)

T. 119 N.

(Joins sheet 84)

(Joins sheet 90)

(Joins sheet 91)

NORTH FORK CROW RIVER

Swesdburg Church

GRAVEL PIT

Tielvemile Creek

16 17 18 19 20 21

WRIGHT COUNTY, MINNESOTA — SHEET NUMBER 9

9

N

R. 26 W.

(Joins sheet 7)

T. 122 N.

(Joins sheet 8)

(Joins sheet 10)

(Joins sheet 24)

PROPOSED GREAT NORTHERN INTERSTATE HIGHWAY NO. 94

NORTH LAKE

WEST LAKE

Silver Creek Church

LAKESIDE CEMETERY

27 26 25 34 35 36

N

(Joins sheet 88)

R. 26 W.

(Joins sheet 89)

T. 119 N.

(Joins sheet 95)

(Joins sheet 92)

NORTH FORK CROW RIVER

GRAVEL PIT

KRIETLER CEMETERY

15 14 13 22 23 24


N
R. 26 W.
T. 119 N.
(Joins sheet 89)
(Joins sheet 86)
(Joins sheet 92)
(Joins sheet 115)
Meister School
WAVERLY LAKE
LITTLE WAVERLY LAKE
MISSION CENTER CEMETERY
ST MARYS CEMETERY
Waverly
NORTHERN GREAT
Twelvemile Creek
Twelvemile Cr
30
29
28
31
32
33

92

N

(Joins sheet 90)

R. 26 W.

T. 119 N.

(Joins sheet 91)

(Joins sheet 97)

(Joins sheet 116)

Bland School

Malardi Lake

Montrose

GREAT NORTHERN

27 26 25 34 35 36


N
R. 25 W.
T. 119 N.
(Joins sheet 65)
(Joins sheet 88)
(Joins sheet 94)
(Joins sheet 95)
MARY LAKE
Mink Lake
Tamarack Lake
Dean Lake
Ilstrup School
Frederick Creek
SOO LINE
25
55
5
6
7
8
9

94

N

(Joins sheet 66)

R. 25 W.

(Joins sheet 93)

(Joins sheet 99)

T. 119 N.

(Joins sheet 96)

Moore Lake

Thompson School

1 2 3 10 11 12

55

SOO LINE


N
(Joins sheet 93)
R. 25 W.
T. 119 N.
Dean Lake
Frederick
Crawford Lake School
Dixon School
CRAWFORD LAKE
NORTH FORK CROW RIVER
Creek
16
17
18
19
20
21
25
(Joins sheet 90)
(Joins sheet 96)
(Joins sheet 97)

96

N

R. 25 W

T. 119 N.

(Joins sheet 94)

(Joins sheet 95)

(Joins sheet 101)

(Joins sheet 98)

Dean Lake

NORTH FORK CROW RIVER

SOO LINE

15 14 13 22 23 24

N

(Joins sheet 95)

R. 25 W.

T. 119 N.

(Joins sheet 92)

(Joins sheet 98)

(Joins sheet 121)

30 29 28 31 32 33

RIVER

NORTH FORK CROW

GREAT NORTHERN

EVANGELICAL CEMETERY

MT OLIVE CEMETERY

CASSEL CEMETERY


N
(Joins sheet 96)
R. 25 W.
T. 119 N.
NORTH FORK CROW RIVER
SOO LINE
27
26
25
34
35
36
(Joins sheet 97)
(Joins sheet 102)
(Joins sheet 122)


N
R. 24 W.
T. 119 N.
(Joins sheet 71)
(Joins sheet 94)
(Joins sheet 100)
(Joins sheet 101)
Moore Lake
LAKE CHARLOTTE
Lake Martha
Wagner Lake
North Rockford School
CROW RIVER
HENNEPIN CO